ENGINEERING

An Illustrated Weekly Journal

35 & 36 BEDFORD STREET, STRAND, LONDON, W.C.2 - - TELEPHONE: TEMPLE BAR 3663

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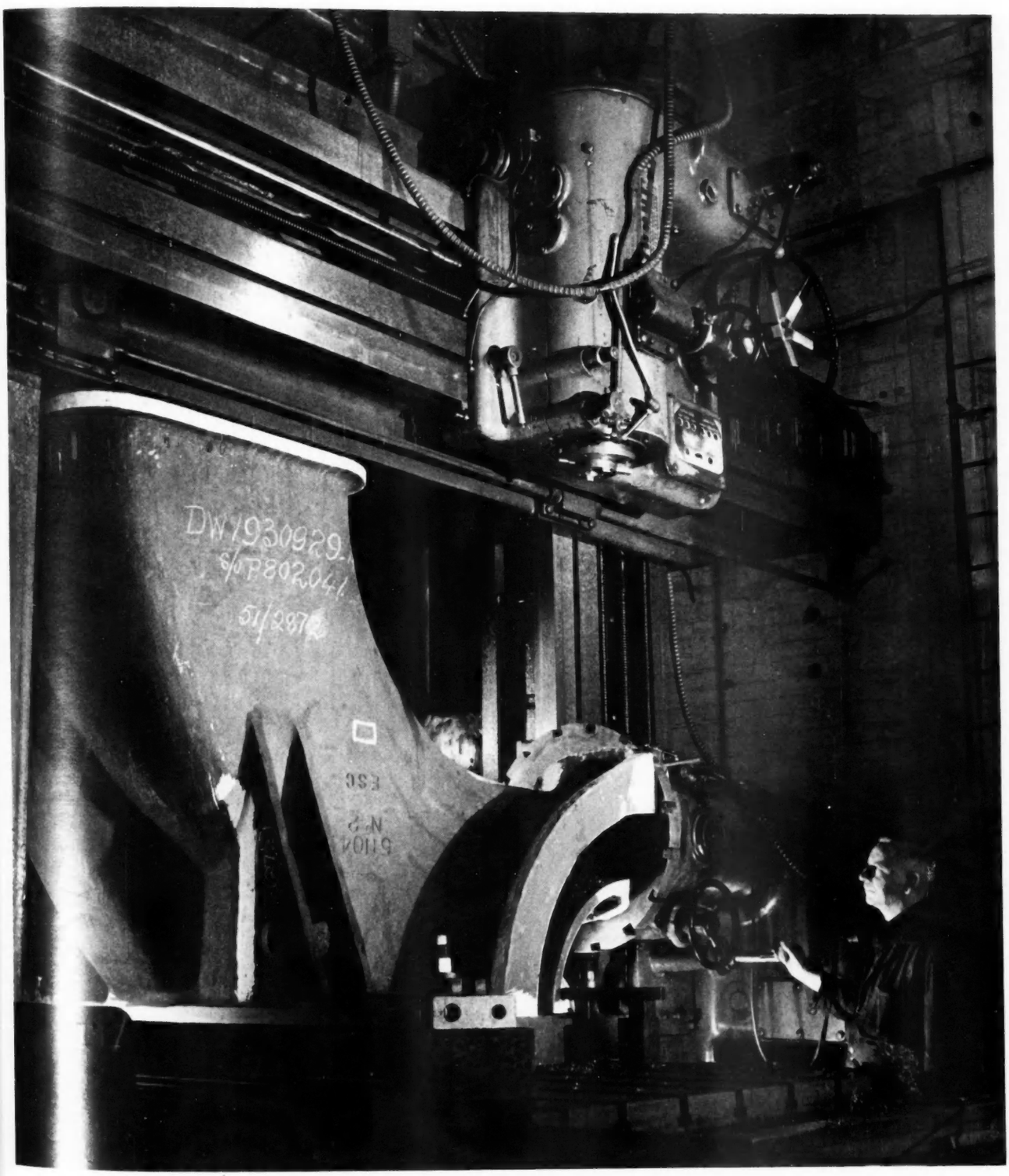

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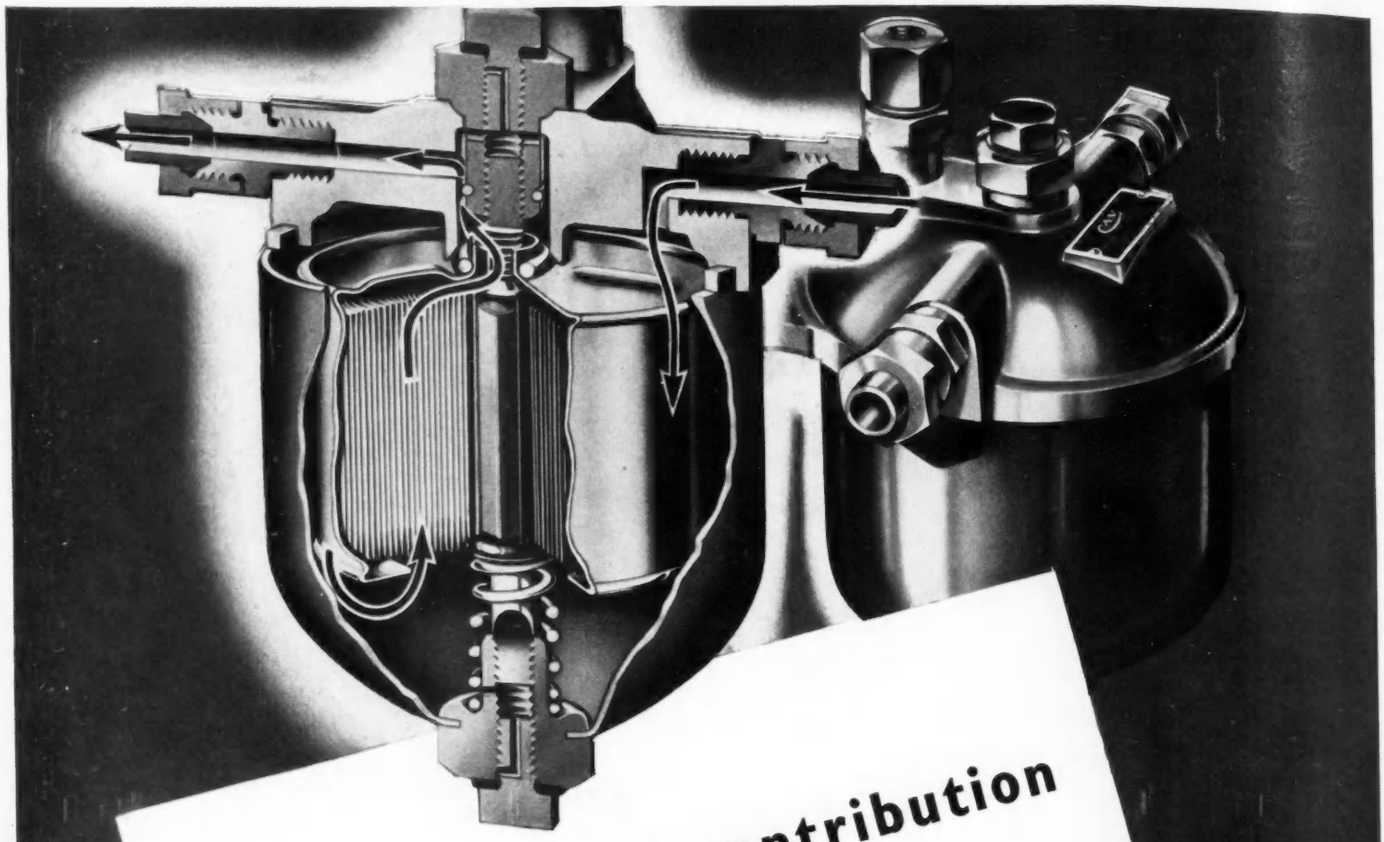

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A Power House of the Thames Board Mills treated with Miroglo. (Photograph by courtesy of Messrs. Thames Board Mills Ltd.)

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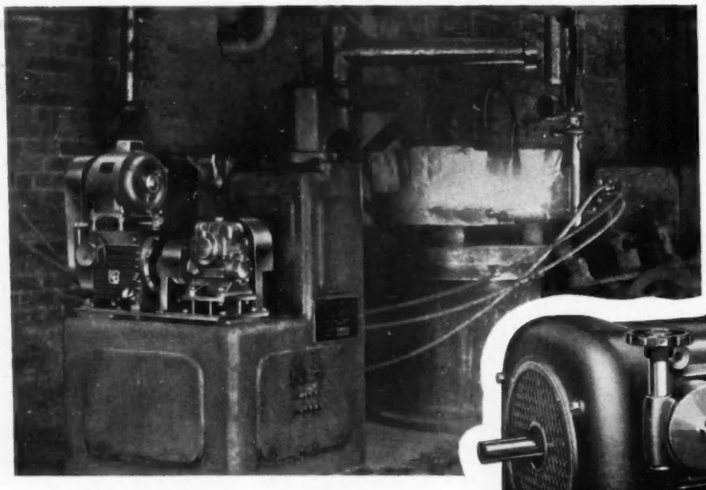

The illustration shows a Size 1A Carter Variable Speed Gear driving a Flame Cutting Machine installed in a Steel Foundry.
Photograph by courtesy of Messrs. Crofts (Engineers) Ltd.

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STAND 137

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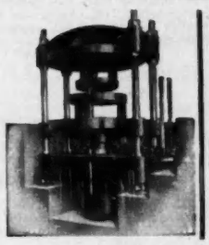

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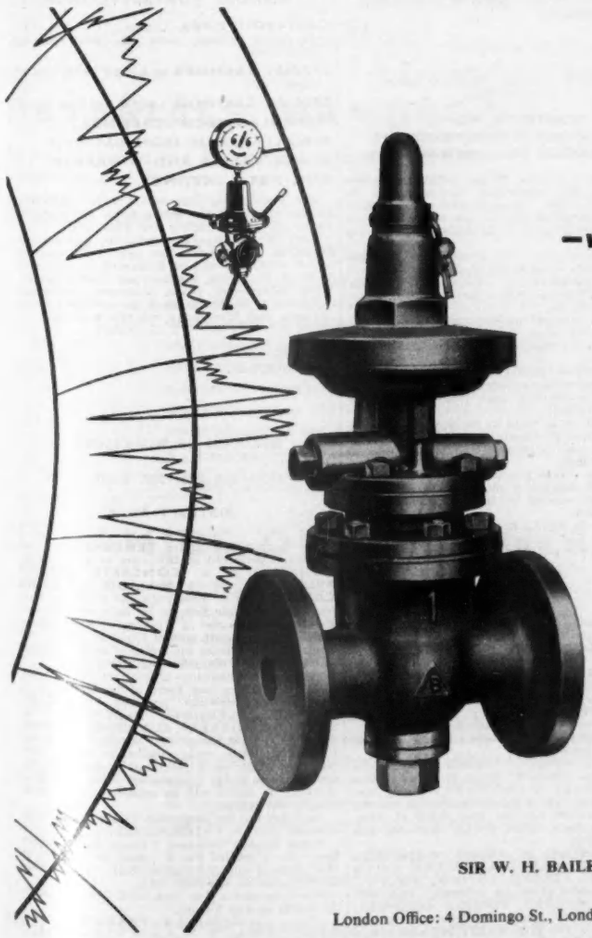

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Bailey's new 'G3' pressure regulators supersede the highly successful 'G2A' series. Stronger construction and greater ease of accessibility for maintenance are special features of this latest series in the Bailey range.

GREATER DURABILITY

The three points where the most wear takes place have been replaced to provide more durability. Pilot valve tops are now of forged bronze or alloy steel and valve and seat materials are harder.

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Spring chambers, pilot valve assembly, and the separate pilot valve strainer are all easily accessible.

EXCELLENT PERFORMANCE

- Close regulation within ± ½ p.s.i. at low reduced pressures.
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BV 11

CLASSIFIED ADVERTISEMENTS SECTION.

For all advertisements classified under the headings of Tenders, Appointments Open, Situations Wanted, Patent Agents, Partnerships, Wanted, &c., Auction Sales, Publications For Sale, Miscellaneous and Public Notices, &c., the charge will be 12s. for the first four lines or under and 3s. per line up to one inch. When an advertisement measures an inch or more, the charge will be at the rate of 36s. per inch. 5% allowed on 6, 10% on 13, 15% on 26 and 20% on 52 Weekly insertions. If use is made of a box number the extra charge is 2s. per insertion with the exception of advertisements appearing under Situations Wanted. Prospectuses and Notices of Company Meetings £25 per column. Copy instructions must be in our hands first post Monday for the following Friday's issue. Address to the Manager, ENGINEERING LTD., 35 and 36, Bedford St., Strand, W.C.2 Inclusion of advertisements must be dependent on space being available.

PUBLIC NOTICES.

ROYAL CORPS OF NAVAL CONSTRUCTORS

SCHOOLS ENTRY.

A COMPETITION for a new form of entry into the Royal Corps of Naval Constructors will be held in July, 1956.

Accepted candidates will be established as Probationers in the R.C.N.C. and will undergo a 2-year course of training at the R.N. Engineering College, Manadon, and in H.M. Dockyard, Devonport, followed by a 3-year course at the R.N. College, Greenwich.

Candidates must be aged between 18 years and 19 years 6 months inclusive on 1st September, 1956.

Candidates with the General Certificate of Education will be required to have passed at Advanced Level in at least Pure Mathematics, Applied Mathematics and Physics, and to produce evidence of general education at Ordinary level.

Candidates with the Scottish Leaving Certificate will be required to have higher grade passes in Physics and Mathematics and at least lower grade passes in English and a language other than English and two other subjects (preferably mathematical).

Candidates from schools in Northern Ireland will be required to produce a certificate from the Ministry of Education in Northern Ireland showing a comparable standard to that above.

The work of the R.C.N.C. covers all aspects of design construction and repair of H.M. Ships Members undertake to serve wherever required at Admiralty Headquarters and outports in the United Kingdom, and at Royal Dockyards at Home and Abroad. The Head of the R.C.N.C. is the Principal Technical Adviser to the Board of Admiralty.

Total pay for probationers will commence at £313 10s. 0d. p.a. at the R.N.E.C. at age 18, rising to £575 at Greenwich at age 23. The successful probationer can expect appointment as Assistant Constructor usually at age 23 with total pay (London) of £805. Promotion to constructor is at about age 30 with total pay of £1399 rising in 9 years to £1750. Promotion to higher ranks with top salary £3500 is by selection.

Full particulars may be obtained from the SECRETARY OF THE ADMIRALTY, C.E. BRANCH II, EMPIRE HOTEL, BATH, to whom final applications must be submitted by 15th June, 1956. K 999

EDUCATIONAL.

FREE. Brochure giving details of courses in Mechanical and Production Engineering, Draughtsmanship, etc., for the A.M.I.Mech.E., A.M.I.P.E., City and Guilds and other Professional examinations. E.M.I. INSTITUTES, DEPT. EG. 30, LONDON, W.4. (ASSOCIATED WITH H.M.V.) G 619

UNIVERSITY OF NOTTINGHAM.

A SENIOR RESEARCH STUDENTSHIP value £500 per annum for not more than three years, is offered as from 1st October, 1956, for research in one of the following subjects: Civil, Mechanical, Electrical or Mining Engineering or Metallurgy. Candidates must be graduates and must have not less than two years' industrial experience, or a professional qualification.

Further information and forms of application may be obtained from THE REGISTRAR, to whom the completed forms must be returned not later than 1st July, 1956. L 311

COURSES.

THE COLLEGE OF AERONAUTICS.

The Board of Entry of the College invites applications from

SUITABLE CANDIDATES FOR THE TWO-YEAR COURSE which begins in October, 1956, and ends in June, 1958.

Candidates should be of graduate standard although the possession of a degree is not essential; a good Higher National Certificate is an acceptable standard.

The College, a post-graduate institution, is devoted to the study of aeronautical science and engineering. The curriculum covers the five main subjects of Aerodynamics, Aircraft Design, Aircraft Electrical Engineering, Aircraft Propulsion and Aircraft Economics and Production. Instruction in the first year is designed to provide all students with a broad background of knowledge in all these subjects, with opportunity for limited specialisation in two or three of them. In the second year, students specialise more particularly, usually in one subject.

Experiments in the air are an important part of the work, both in the first year when all students take part in them and in the second year when they are linked to the specialist work of the departments.

Students who satisfactorily complete the course will receive the Diploma of the College.

Further particulars and details of the procedure for enrolment may be obtained from:

THE WARDEN,
THE COLLEGE OF AERONAUTICS,
CRANFIELD,
BLETCHLEY,
BUCKS. L 164

UNIVERSITY OF BIRMINGHAM.

DEPARTMENT OF MECHANICAL ENGINEERING.

GRADUATE SCHOOL OF THERMODYNAMICS AND RELATED SUBJECTS.

A COURSE available in the above School provides facilities for the study, at advanced level, of modern developments in Thermodynamics and allied subjects and of their applications in the general field of the heat engine. The normal entrance qualifications are an Honours Degree in Mechanical Engineering together with a minimum of two years of practical experience in industry. On completion of the twelve-month course commencing on 1st October, 1956, and including nine months attendance at the University, successful candidates qualify for the award of the degree of Master of Science. In special circumstances applications may be considered from graduates in other Sciences who hold satisfactory alternative qualifications. In the latter case it will usually be necessary for two years to be spent in completing the course. The award to successful non-graduate engineers is the Diploma of Graduate Studies.

The inclusive fee for the course of study is £71 1s. In certain cases where a student is not sponsored by an employer, the University may consider applications for the remission of this fee and, where essential, for the grant of a maintenance allowance during the period of attendance.

Further particulars and application forms may be obtained from the Registrar, The University, Birmingham, 15. Applicants are advised to apply before 1st August but applications received after this date may be considered if places are available.

G. L. BARNES,
Secretary. L 248

The University,
Birmingham, 15.

THE COLLEGE OF AERONAUTICS.

TWO-YEAR COURSE.

The Board of Entry of the College invites applications from suitable candidates for the TWO-YEAR COURSE which begins in October, 1956, and ends in June, 1958.

Candidates should be of graduate standard although the possession of a degree is not essential; a good Higher National Certificate is an acceptable standard.

The College, a post-graduate institution, is devoted to the study of aeronautical science and engineering. The curriculum covers the five main subjects of Aerodynamics, Aircraft Design, Aircraft Electrical Engineering, Aircraft Propulsion and Aircraft Economics and Production. Instruction in the first year is designed to provide all students with a broad background of knowledge in all these subjects, with opportunity for limited specialisation in two or three of them. In the second year, students specialise more particularly, usually in one subject.

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THE WARDEN.
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CRANFIELD,
BLETCHLEY, BUCKS. L 322

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Northampton Grove, Canonbury, London, N.1. Canonbury 4244/5/6. We have over 25 years' experience of experimental work and prototypes. We design, develop and manufacture special purpose and labour saving machines, all at the above address. Our range is from the smallest scientific instruments to 3- or 4-ton machines. After a prototype machine has been made and found satisfactory we can manufacture as many as are required. G 656

LECTURES.

UNIVERSITY OF LONDON.

A COURSE OF FOUR LECTURES on (i and ii) "Experiments and Experiences with High Grade Corrugated Reinforcing Steel of the Qualities kam 60 and kam 95, Corresponding to Yield Points 85000 and 135000 p.s.i." and (iii and iv) "Problems Concerning Pile Driving and Foundation on Piles of Timber, Concrete and Steel in Sweden," will be given by PROFESSOR H. GRANHOLME (Göteborg), at 5.30 p.m. on 7, 8, 9 and 11 May at King's College, Strand, W.C.2. ADMISSION FREE, WITHOUT TICKET. James Henderson, Academic Registrar. L 307

TENDERS.

THE DIRECTOR GENERAL, INDIA STORE DEPARTMENT, GOVERNMENT BUILDING, BROMYARD AVENUE, ACTON, LONDON, W.3, invites

TENDERS for the supply of:—

OPTICAL LENS AND GLASS WORKING MACHINERY FOR GRINDING, POLISHING, SLITTING, ETC.

Tenders, schedule and specifications may be purchased from the above address at a cost of Ten Shillings, quoting reference 2902/55/CIV3.

Tenders complete with specifications are to be submitted by Friday, the 8th June, 1956. L 277

LINDSEY COUNTY COUNCIL
HIGHWAYS DEPARTMENT.

(1) CONSTRUCTION OF KEADBY LOCK SWING BRIDGE, B1392.
(2) ALTERATIONS TO BARDNEY JOINT BRIDGE B1190.

TENDERS are invited for the above works which are situated some 40 miles apart.

1. Keadby Lock Swing Bridge is situated on the Sheffield and South Yorkshire Canal in the village of Keadby four miles west of Scunthorpe. The works consist of the construction of a new reinforced concrete substructure, including piling, and the provision and erection of an electrically operated welded steel swing bridge together with all controls and ancillary works.

2. Bardney Bridge is a 100 ft. span lattice girder bridge over the River Witham 10 miles east of Lincoln and the works consist of strengthening by means of piled concrete supporting frames and a new welded steel plate deck, together with a new cantilevered footway.

Contract documents are obtainable from MESSRS. WILTON & BELL, 25, VICTORIA STREET, S.W.1, on payment of £3 deposit for each set returnable for a bona fide tender. Plans, etc., may be inspected at the offices of the Consultants or the undersigned.

Tenders MUST be received by the undersigned by 10 a.m. on Saturday, 2nd June, 1956, in a sealed envelope marked "Keadby Lock Swing Bridge," and/or "Bardney Joint Bridge," and may be submitted for either or both contracts.

The Council do not bind themselves to accept the lowest or any Tender.

G. K. TALLACK, A.M.I.C.E.,
COUNTY SURVEYOR.

COUNTY OFFICES,
LINCOLN. L 92

RUNCORN-WIDNES BRIDGE JOINT COMMITTEE.

CONTRACT NO. 2,
MAIN BRIDGE SUPERSTRUCTURE, NEW BRIDGE, RUNCORN-WIDNES.

The Runcorn-Widnes Bridge Joint Committee will shortly be considering inviting firms to **TENDER** for the superstructure of the Main Bridge, and steelwork contractors who wish to be considered should apply to the undersigned as soon as possible.

The Bridge is to cross the River Mersey and the Manchester Ship Canal at the above towns and will be the largest arch bridge in the United Kingdom. The work on Contract No. 1 for the sub-structure is now commencing.

The following conditions will apply:—

(1) Applicants must be steelwork contractors, experienced in the fabrication and erection of large steel bridges;

(2) Applications should be accompanied by details of large bridge construction carried out and photographs or drawings and details of spans of bridges constructed;

(3) All steel to be used in the work is to be to British Standard Specification and to be of British manufacture and applicants should be able to comply with this;

(4) General contractors who propose to employ steelwork sub-contractors should not apply.

Applications should be in my hands by the 5th MAY, 1956.

R. ADCOCK,
Clerk to the Joint Committee.

County Hall,
Preston. L 287

THE MARITIME SERVICES BOARD OF NEW SOUTH WALES.
CONTRACT NO. 56/4.

TENDERS are invited for the supply, manufacture, testing, delivery and maintenance of **ONE 16-IN. CUTTER SUCTION DREDGER (NON-PROPELLED);**

(*a*) delivered completely assembled, or
(*b*) delivered in prefabricated parts for assembly by the Board,

with complete equipment including two 16-in. pumps in series, separately driven by diesel engines of at least 500 b.h.p. and suitable for dredging from a depth of 42 ft. whilst delivering through floating and shore pipeline not less than 5,800 ft. long. Main and auxiliary diesel driven alternator sets are also required.

Specifications may be obtained on application from the AGENT GENERAL FOR NEW SOUTH WALES, 56-57, STRAND, LONDON, W.C.2.

Tenders in sealed envelopes, endorsed "TENDER FOR 16-IN. CUTTER SUCTION DREDGER, CONTRACT 56/4," must be delivered to the HEAD OFFICE OF THE MARITIME SERVICES BOARD, CIRCULAR QUAY, SYDNEY, NEW SOUTH WALES, not later than 2 p.m. on Monday, 9th July, 1956. L 324

THE HIGH COMMISSIONER FOR INDIA invites **TENDERS** for the supply of:—

	I.R.S. Specn.	Quantity, Sets
BOILER CLOTHING SHEETS	M.16	7 Nos.
BOILER PLATES OF VARIOUS SIZES ...	R.29	37
DITTO.	R.21	11
BOILER PLATES flanged of various sizes	R.29	26
DITTO.	R.21	29
DITTO.	M.6	5

Forms of tender may be obtained from the DIRECTOR GENERAL, INDIA STORE DEPARTMENT, GOVERNMENT BUILDING, BROMYARD AVENUE, ACTON, LONDON, W.3, on or after 1st May, 1956, at a fee of 10s. which is not returnable. If payment is made by cheque, it should please be made payable to "HIGH COMMISSIONER FOR INDIA." Tenders are to be delivered by 2 p.m. on Friday 1st June, 1956.

Please quote reference No. 421/55/RLY. L 336

THE HIGH COMMISSIONER FOR INDIA invites **TENDERS** for the supply of:—

	Quantity, Nos.
CROSS HEADS FOR YP AND YG CLASS LOCOMOTIVES	120

Forms of tender may be obtained from the DIRECTOR GENERAL, INDIA STORE DEPARTMENT, GOVERNMENT BUILDING, BROMYARD AVENUE, ACTON, LONDON, W.3, on or after 27th April, 1956, at a fee of 10s. which is not returnable. If payment is made by cheque, it should please be made payable to "HIGH COMMISSIONER FOR INDIA." Tenders are to be delivered by 2 p.m. Tuesday, 29th May, 1956.

Please quote reference No. 437/55/RLY. L 337

CITY OF NOTTINGHAM.

WATER DEPARTMENT.

ANNUAL CONTRACTS, 1956-57.

CAST-IRON PIPES, Classes "C" and "D" (including ordinary sand cast, sand spun and spun iron).

SPECIAL CASTINGS up to and including 6 in., Class "CD."

SPECIAL CASTINGS over 6 in., Class "CD."

IRREGULAR SPECIAL CASTINGS, Class "CD."

MISCELLANEOUS IRON CASTINGS.

SLUICE VALVES AND HYDRANTS.

GUN METAL FITTINGS.

The Nottingham Corporation invite **TENDERS** for the supply of the above stores and materials, for the 12 months ending 30th June, 1957.

Copy of the General Conditions, Specifications, Forms of Tender, etc., for any of the contracts above mentioned will be forwarded on application to Mr. B. W. Davies, Engineer and General Manager, Water Department, Castle Boulevard, Nottingham.

Tenders to be sent to me in the envelope provided not later than Wednesday, the 23rd May, 1956.

T. J. OWEN,
Town Clerk.

Guildhall,
Nottingham. L 320

BOROUGH OF WORKINGTON.

STAINBURN SERVICE RESERVOIR.

CONTRACT NO. 6.

The Corporation invite **TENDERS** from contractors experienced in this class of work for the construction of a **CONCRETE SERVICE RESERVOIR OF 3 MILLION GALLONS CAPACITY,** with mass walls and reinforced floor, roof and partition wall, to be built at Stainburn, situated 1½ miles east of Workington Main Railway Station, on the north side of Highway A 595. The Contract also includes the laying of about 700 yards of 6 in. to 21 in. diameter spun iron pipes.

The General Conditions of Contract, Specification, Bill of Quantities and Form of Tender and a set of Contract Drawings prepared by MESSRS. HERBERT LAPWORTH PARTNERS, CONSULTING ENGINEERS, 25, VICTORIA STREET, WESTMINSTER, may be obtained from the UNDERSIGNED upon application on or after 7th May, 1956, on payment of a cheque for £5, made payable to the Corporation of the Borough of Workington, which will be refunded on receipt of a bona fide tender.

Facilities for the inspection of the site may be obtained from the UNDERSIGNED.

Sealed Tenders endorsed "Tender for Stainburn Reservoir—Contract No. 6" shall be delivered at the office of the UNDERSIGNED by or before the first post on 4th June, 1956.

The Corporation does not bind itself to accept the lowest or any Tender.

RUSSELL C. PHARAOH,
Town Clerk.

Town Hall,
Workington,
Cumberland. L 347

PUBLIC APPOINTMENTS.

LIVERPOOL REGIONAL HOSPITAL BOARD.

Applications invited for permanent pensionable appointment of

ASSISTANT ENGINEER (Mechanical, Heating and Ventilating) in the Regional Engineer's Department.

Applicants should have served a recognised engineering apprenticeship; be Graduates of the Institution of Mechanical Engineers or Corporate Members of the Institution of Heating and Ventilating Engineers. A wide experience of heating, ventilating, domestic hot water plants and pumping plants and a knowledge of laundry and kitchen plant will be an advantage.

The duties include carrying out surveys, preparation of drawings, estimates and specifications, particularly for heating and ventilation schemes.

Salary scale £640-£930. Commencing salary dependent on age and experience.

Applications stating age, qualifications, experience, present and previous appointments, with names and addresses of three referees (two technical) to me at 19, JAMES STREET, LIVERPOOL, 2, not later than 25th MAY, 1956.

VINCENT COLLINGE,
Secretary to the Board. L 297

HER MAJESTY'S OVERSEA CIVIL SERVICE.

SENIOR MECHANICAL ENGINEER,
PUBLIC WORKS DEPARTMENT,
SIERRA LEONE.

Required for supervision and control of Public Works Department Mechanical Workshops, Vehicular Transport; building and road construction plant, etc., also maintenance of minor Water Supply pumping stations.

Appointment is pensionable in salary range £1442-£1652 or contract appointment in salary range £1558-£1857. Point of entry according to experience and war service. Gratuity of £37 10s. payable for each completed period of three months service, on satisfactory completion of contract appointments. Outfit allowance of £60 payable on first appointment.

Free passage provided for officer and wife. Free passages provided or allowances of £75 per annum for maximum of two children. Quarters provided, if available, at reasonable rental. Seven days leave for each completed month of resident service.

Candidates aged 26-40, must be A.M.I.Mech.E. or have passed or be exempt from Parts A and B of the Institution's examinations, with at least four years practical experience after qualifying, and a good knowledge of Diesel Engines. Experience of road construction and earth moving equipment would be an advantage.

Apply: DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, S.W.1, giving age, qualifications and experience. Mention BCD 112/15/09. L 262

GOLD COAST LOCAL CIVIL SERVICE.

MOTIVE POWER SUPERINTENDENT.

GOLD COAST RAILWAY.

To take charge of Running Section of Locomotive Department.

Contract appointment at fixed salary of £2040 p.a. Gratuity £12 10s. for each completed month of satisfactory service. Free passages provided for officer, wife, and three children under age of 13. Quarters provided, when available, rental £90 p.a. Seven days leave for each month of resident service.

Candidates aged between 35 and 50, must be A.M.I.Mech.E. or hold an Engineering Degree from a recognised University and have experience in the maintenance and running of locomotives, carriages and wagons, water supply and similar equipment on a railway. They must have at least seven years experience as a Locomotive Superintendent.

Apply in writing to the DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1, giving briefly age, qualifications and experience. Mention the reference number BCD 110/13/04. L 240

CENTRAL ELECTRICITY AUTHORITY,
YORKSHIRE DIVISION.

OPERATIONAL RESEARCH SECTION.

Applications are invited for the following appointments in the Operational Research Section of the Generation Operation Department, Divisional Headquarters, Leeds.

SENIOR ASSISTANT ENGINEER.

Commencing salary within the range £1100-£1225 per annum, Grade 4, Class AX, National Joint Board Agreement (Schedule C), according to qualifications and experience, rising to an ultimate maximum of £1345 per annum (Class EX).

THIRD ASSISTANT ENGINEERS (2).

Commencing salary within the range £750-£875 per annum, Grade 4, Class AX, National Joint Board Agreement (Schedule C), according to qualifications and experience, rising to an ultimate maximum of £975 per annum (Class EX).

This is a new section and the work will involve the application of Operational Research techniques to investigations into the performance of generating plant and the study of methods of increasing plant availability and improving the economy and efficiency of operation.

Applicants should be fully qualified electrical or mechanical engineers and previous experience of Operational Research is desirable but not essential as there will be opportunities for training in the techniques.

Application forms, obtainable from the DIVISIONAL SECRETARY (ESTABLISHMENTS), CENTRAL ELECTRICITY HOUSE, ST. MARY'S ROAD, LEEDS, 7, should be returned within 14 days of the appearance of this advertisement.

G. A. VOWLES,
Divisional Controller. L 245

THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT,
WOOLWICH COMMON,
requires

ENGINEERS Basic Grade

POST (A), REF. 1116/26. To maintain liaison with a production organisation engaged on the manufacture of a wide range of complex electronic instruments, and to supervise functional inspection work. Applicants should have several years' experience in the production of electronic equipment or in liaison work.

POST (B), REF. 1117/26. To organise and supervise the installation of complex electronic equipment into caravans, trailers, etc., for field use overseas. The installation problems include R.F. shielding, cooling, anti-vibration, mounting, etc. Applicants should have several years' experience in installation engineering of electronic equipment.

Candidates for both posts should have served a recognised engineering apprenticeship or have undergone equivalent training in the field of electronics and should be corporate members of the Institution of Electrical Engineers or have exempting qualifications.

SALARY: £769 8s.-£1193 14s. per annum.

Contributory Superannuation Scheme. Requests for application forms by POSTCARD to SENIOR RECRUITMENT OFFICER, A.W.R.E., ALDERMASTON, BERKSHIRE, not later than 1st MAY, 1956, quoting the appropriate reference number. L 271

HERTFORDSHIRE COUNTY COUNCIL.

HATFIELD TECHNICAL COLLEGE,
ROE GREEN, HATFIELD, HERTS.

Principal: DR. W. A. J. CHAPMAN, M.Sc.(Eng.).

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING.

ASSISTANT GRADE B IN MECHANICAL ENGINEERING.

The work will be concerned mainly with National Certificate in Mechanical Engineering and City and Guilds Machine Shop Engineering. Essential qualifications: sound industrial experience, good technological qualifications and teaching experience. (M/P 1).

ASSISTANT GRADE B IN WELDING AND SHEET METALWORK.

Applicants should be suitably qualified and experienced to conduct classes to Final City and Guilds of London Institute standard. (M/P 2).

Salary in both posts in accordance with the provisions of the Burnham (Further Education) Report 1954: £525-£820 with additions for training and appropriate qualifications. Further particulars and application forms (s.a.e.) from THE REGISTRAR. L 303

UNIVERSITY OF CAPE TOWN,
SOUTH AFRICA.

Applications are invited for the

CHAIR OF MECHANICAL ENGINEERING

The salary scale is £1600 by £100 to £1950. There is also a temporary cost of living allowance for a married man (at present £234 per annum).

Applications (with copies of testimonials) should state age, qualifications, experience and research completed or in progress and give the names of two referees whom the University may consult. Two copies of the application and testimonials should reach the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1 (from whom memoranda giving the general conditions of appointment and further information about the work of the department of Mechanical Engineering should be obtained) not later than 7th JUNE, 1956. An additional copy should be sent direct by air mail to THE REGISTRAR, UNIVERSITY OF CAPE TOWN, PRIVATE BAG, RONDEBOSCH, CAPE TOWN, SOUTH AFRICA, by the same date.

The University reserves the right to appoint a person other than one of the applicants or to make no appointment. L 308

BRITISH TRANSPORT COMMISSION.

PRINCIPAL required for the Commission's residential Work Study Training Centre being established near Watford. Thirty to forty students; training to advanced level in all aspects of Work Study technique and its application to transport staff employed in a wide variety of work.

Commencing salary £2000 to £2500 a year according to qualifications, with membership of a Superannuation Fund subject to Rules of Fund. Medical examination. Certain free travelling facilities.

The successful candidate must have a thorough knowledge of Work Study, administrative ability and experience in the running of a residential training establishment for senior staff. An Engineering degree and/or teaching diploma would be an advantage.

Applications giving full particulars of education, age and experience (teaching, technical and administrative) should be sent within fourteen days to the MANPOWER ADVISER, BRITISH TRANSPORT COMMISSION, 222, MARYLEBONE ROAD, LONDON, N.W.1. L 255

BEDFORDSHIRE EDUCATION COMMITTEE.

LUTON COMMITTEE FOR EDUCATION.

LUTON AND SOUTH BEDFORDSHIRE COLLEGE OF FURTHER EDUCATION.

Principal: W. F. STEPHENSON, B.Sc., F.R.I.C.

Applications are invited for the following posts, duties to commence on 1st September, 1956:—

ASSISTANT (GRADE B) IN MATHEMATICS

Candidates should possess a good University degree. Duties will include teaching of students preparing for G.C.E. (Ordinary and Advanced), B.Sc. (General), and Ordinary and Higher National Certificates in Engineering.

Salary will be in the range £525 by £25 to £820.

ASSISTANT (GRADE A) IN ENGLISH

Salary will be in the range £450 by £18 to £725.

Send s.a.e. (foolscap), for application form, which should be returned within ten days of the appearance of this advertisement to J. A. CORBETT, CLERK OF THE GOVERNORS, 63/69, GUILDFORD STREET, LUTON. L 256

SCOTTISH HOME DEPARTMENT.

FISHERY PROTECTION AND RESEARCH SHIPS.

The Civil Service Commissioners invite applications for pensionable posts, two of

SECOND OFFICER and three of **SECOND ENGINEER.** Age at least 23 on 1st February, 1956. Candidates must hold the following qualifications:—

SECOND OFFICER: Board of Trade or Ministry of Transport and Civil Aviation Certificate of Competency as Master (Home Trade); but preferably Foreign or Extra Master.

SECOND ENGINEER: Board of Trade or Ministry of Transport and Civil Aviation First Class Certificate of Competency in Steam or Motor; but preferably the Certificate in both Steam and Motor or the Extra First Class Certificate.

Inclusive salary scales are on the basis of finding own food:—

Second Officer: £645-£755.
Second Engineer: £750-£905

These scales are subject to deductions for posts outside London.

Uniform and victualling allowances and addition for engineers on Diesel engined vessels.

Further particulars and form of application from the ESTABLISHMENT OFFICER, ROOM 364, SCOTTISH HOME DEPARTMENT, ST. ANDREW'S HOUSE, EDINBURGH, 1. Application Form to be returned by 31st May, 1956. L 309

HER MAJESTY'S OVERSEA CIVIL SERVICE.

MECHANICAL ENGINEER, P.W.D.
SARAWAK.

TO TAKE CHARGE OF THE MECHANICAL SECTION OF THE P.W.D. IN SARAWAK.

Appointment is pensionable or on agreement for three years in first instance in salary range £1141-£2000, plus cost-of-living allowance. Point of entry determined by experience. Free passages for officer, wife and up to three children under 18. Four days leave for every month of resident service. Quarters provided; rental £28-£84 per annum.

Candidates should be A.M.I.Mech.E., or possess a Degree or Diploma recognised by the Institution as granting exemption from Parts A and B of its examinations. Must be a capable organiser and administrator and have a wide experience of workshop practice, operation and maintenance of mobile equipment, field plant, etc.

Apply: DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1, giving age, qualifications and experience. Mention BCD 112/24/014. L 263

ESSEX.

NORTH-EAST ESSEX TECHNICAL COLLEGE AND SCHOOL OF ART, COLCHESTER.

ASSISTANT GRADE "A" required in September, 1956, to teach mainly Workshop and Motor Vehicle Practice up to Final City and Guilds of London Institute level. Ability to assist with Welding an advantage.

Salary: £450 by £18 to £725 with additions for graduation or equivalent qualification and training. Increments on the scale allowed for teaching service, war/national service and approved industrial experience.

Details and forms (stamped addressed foolscap envelope) from the CLERK TO THE GOVERNORS, DIVISIONAL EDUCATION OFFICE, PARK ROAD, COLCHESTER. L 244

LONDON TRANSPORT
require

DRAUGHTSMEN
for Chiswick Works.

Qualifications: Preferably some experience of bus, body and chassis work; previous drawing experience; ability to produce detail and assembly drawings from instructions; apprenticeship and ordinary or higher national certificates advantageous. Salary range £340-£710, with additional payments for certain recognised qualifications. Medical exam.; contributory superannuation scheme after probation; free travel.—Applications to RECRUITMENT AND TRAINING OFFICER (F/EV 574), LONDON TRANSPORT, 55, BROADWAY, S.W.1. For acknowledgment enclose addressed envelope. L 247

Classified Advertisements continued on Page 4

MATERIALS HANDBOOK

An Encyclopædia for Purchasing Agents, Engineers, Executives and Foremen

GEORGE S. BRADY

EIGHTH EDITION

This widely-used handbook gives practical information on over 9000 materials—metals, alloys, refractories, abrasives, woods, synthetic resins and industrial chemicals. It describes their properties, characteristics and uses, as well as adulterants and substitutes for them. In this new edition nearly a thousand materials have been added, including electronic materials such as the semi-conductors, and heat resistant materials used in the latest jet engines.

9 x 6 inches 1022 pages 82s 6d

Already published

DYNAMICS OF MACHINERY

J. B. HARTMAN Professor of Mechanical Engineering
LeHigh University

The second volume in our new Mechanical Engineering Series edited by R. G. Folsom

This book teaches techniques in the design and control of modern high speed machinery which are needed by the engineer and cannot adequately be covered in the usual elementary mechanics course. It provides a transition from basic work in mechanics to more advanced graduate work in dynamics, and introduces certain mathematical techniques used for automatic controls and servomechanisms.

9 x 6 inches 289 pages 56s 6d

Available shortly from your bookseller

McGRAW-HILL PUBLISHING COMPANY

GOVERNMENT OF MAURITIUS.

ASSISTANT WORKS MANAGER,
RAILWAYS DEPARTMENT.

Required in connection with planning and execution of the programme for repairs maintenance and general overhaul of some 40 steam and 2 diesel hydraulic 625 h.p. locomotives, 650/700 freight wagons and brake vans; supervise mechanical work at Central and District Running Sheds; provide motive power to requirements of District Superintendent; train local personnel on mechanical engineering work and act as Works Manager when necessary.

Contract appointment for three years. Salary up to £1500 p.a., dependent on qualifications and experience; plus temporary variable cost-of-living allowance. Gratuity of £37 10s.-£50 per quarter payable on satisfactory completion of contract.

Free passages for officer, wife and three children. Quarters if available. Four days leave for each month of resident service.

Candidates should be A.M.I.Mech.E., or have passed or be exempt from Sections A and B of the examinations of the Institution of Mechanical Engineers. Experience of planning and programming in locomotive erecting shops and control of labour is essential and preferably experience of diesel engines.

Apply: DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1, stating age, qualifications and experience and quoting BCD 110/52/02. L 264

LINDSEY COUNTY COUNCIL
EDUCATION COMMITTEE.

COUNTY TECHNICAL COLLEGE,
GAINSBOROUGH.

Principal: P. F. MORTON, B.Sc., A.Inst.P.

Applications are invited for the post of **ASSISTANT LECTURER, GRADE A, IN GENERAL ENGINEERING SUBJECTS,** duties to commence 1st September, 1956. This post is largely for Pre-Senior, City and Guilds and O.N.C. courses, but a suitable candidate would be given an opportunity for advanced work at a later stage.

Further particulars of the post and application forms may be obtained from the County Technical College, Morton Terrace, Gainsborough, Lincs., on receipt of a stamped addressed envelope. Completed forms should be returned to the Principal within two weeks of the appearance of this advertisement.

F. J. BIRKBECK, DIRECTOR OF EDUCATION, BOX 20, COUNTY OFFICES, LINCOLN. L 266

NORTHAMPTON POLYTECHNIC,
ST. JOHN STREET, E.C.1.

GRADUATE RESEARCH ASSISTANTS are required in the Civil and Mechanical Engineering Department for experimental work in connection with (1) Fatigue of Metals, (2) Strain-hardening of Steel.

Applicants should be graduates in, Engineering or Metallurgy. The research assistants will receive salaries of £400 p.a. and will be provided with opportunities for obtaining a higher degree. Appointments, dating from September, 1956, or earlier, will be initially for one year but may be extended for a further period.

Application should be made by letter, addressed to the Head of the Civil and Mechanical Engineering Department.

J. E. RICHARDSON,
Ph.D., B.Eng., M.I.E.E., A.M.I.Mech.E.,
Principal. L 272

COUNTY BOROUGH OF BRIGHTON
EDUCATION COMMITTEE.

BRIGHTON TECHNICAL COLLEGE.

Principal: G. E. WATTS, M.A., Ph.D.(Cantab.), B.Sc.(Lond.), F.R.I.C.

Required for September 1st:—

ASSISTANT LECTURER (GRADE B) IN MECHANICAL ENGINEERING. Graduate, A.M.I.Mech.E. or A.M.I.Prod.E. Salary £525 by £25 to £820 (men), £489-£820 (women) plus graduate and training allowances and with increments for approved research, professional or industrial experience.

Further particulars and forms of application from the undersigned, to be returned to the PRINCIPAL, BRIGHTON TECHNICAL COLLEGE, BRIGHTON, 7, by not later than 12th May, 1956.

W. G. STONE,
Director of Education.

54, Old Steine,
Brighton. L 273

CITY OF LIVERPOOL.
EDUCATION COMMITTEE.

CITY COLLEGE OF TECHNOLOGY,
BYROM STREET, LIVERPOOL, 3.

Principal: E. G. EDWARDS, B.Sc., Ph.D., F.R.I.C.

Applications are invited for the appointment of **HEAD OF THE DEPARTMENT OF CIVIL, MECHANICAL AND MARINE ENGINEERING.** Salary £1365 by £25 to £1515 per annum (Burnham Technical Report for a Grade IV Head of Department).

Applicants should possess high academic qualifications in engineering with industrial, and preferably research experience, and should be capable of directing the teaching and administration of a large and expanding Department.

The Department is mainly concerned with work of advanced and professional standard and has recently commenced industrially-based Sandwich Courses in Mechanical Engineering.

Particulars of appointment and application forms (returnable by 12th May, 1956) can be obtained from H. S. MAGNAY, M.A., DIRECTOR OF EDUCATION, 14, SIR THOMAS STREET, LIVERPOOL, 1.

THOMAS ALKER,
Town Clerk and Clerk to the Local Education Authority. (J.4305) L 275

LONDON COUNTY COUNCIL.

SOUTH EAST LONDON TECHNICAL COLLEGE,

ASSISTANT, GRADE B, FOR PRODUCTION ENGINEERING SUBJECTS. Should be graduates of a British University and/or corporate members of the Institution of Mechanical Engineers with good workshop and drawing office experience and preferably some teaching experience. Burnham F.E. salary scale £561-£1012, individual commencing and maximum salary according to age, qualifications and experience.—Application forms from SECRETARY AT COLLEGE, LEWISHAM WAY, S.E.4, to be returned by 11th May. (749) L 286

SURREY EDUCATION COMMITTEE.

BROOKLANDS COUNTY TECHNICAL COLLEGE,
HEATH ROAD, WEYBRIDGE.

Applications are invited for the following posts:—

DEPARTMENT OF ENGINEERING.

(1) ASSISTANT GRADE "B" IN MECHANICAL ENGINEERING. Applicants should be graduates of a British University and/or corporate members of the Institution of Mechanical Engineers and have had adequate industrial and teaching experience. Candidates will be required to teach up to the Ordinary and possibly Higher National Certificate standard.

(2) ASSISTANT GRADE "B" IN PRODUCTION ENGINEERING. The work will be concerned with Ordinary National Certificate courses, and City and Guilds Trades courses requirements in allied subjects. Work up to Higher National Certificate standard may be developed.

(3) ASSISTANT GRADE "B" IN ELECTRICAL ENGINEERING for National Certificate and City and Guilds courses (other than Installation course). Experience in light current work is desirable.

Further details and forms of application obtainable from the PRINCIPAL, to whom they should be returned as soon as possible. L 246

MANCHESTER COLLEGE OF TECHNOLOGY.
(Faculty of Technology in the University of Manchester).

Appointment of
LECTURERS IN MECHANICAL ENGINEERING.

The Governing Body invites applications from University Graduates for **TWO LECTURESHIPS IN MECHANICAL OR PRODUCTION ENGINEERING** in the College of Technology with the title and status of Lecturer in the University of Manchester.

The Department covers a very wide range of aspects of Mechanical and Production Engineering, and all members of staff are expected to undertake, assist in or supervise research, for which the Department is excellently equipped. There is particular need at present for men interested in Fluid Mechanics and Hydraulic Servomechanisms and the fundamental processes of Production Engineering. Graduates in Physics might well be considered if they had special interests of value to the Department.

Salary: £650 per annum, rising by annual increments of £50 to £1350 per annum. Commencing salary according to qualifications. Superannuation under the F.S.S.U. Family Allowances.

Conditions of appointment and form of application may be obtained from the REGISTRAR, COLLEGE OF TECHNOLOGY, MANCHESTER, 1. The last date for receipt of applications is FRIDAY, 1st JUNE, 1956.

B. V. BOWDEN,
Principal of the College. L 259

CITY OF OXFORD EDUCATION COMMITTEE.

COLLEGE OF TECHNOLOGY,
ART AND COMMERCE.

ENGINEERING DEPARTMENT.

Applications are invited from suitably qualified candidates for the following full-time appointments to new posts consequent upon the development of the work of the College:—

(A) LECTURER IN MECHANICAL ENGINEERING SUBJECTS for teaching Strength of Materials, Theory of Machines and Applied Thermodynamics to part-time day and evening students in Higher National Certificate and to full-time students in Diploma courses. Good Honours Degree in Mechanical Engineering with industrial and teaching experience desirable.

(B) WORKSHOP INSTRUCTOR (ASSISTANT GRADE A) to teach ENGINEERING WORKSHOP PRACTICE to students in craft courses. Good industrial and some teaching experience desirable. Working knowledge of Pattern Making and Foundry Practice an advantage.

Salaries in accordance with the 1954 Burnham Further Education Report, i.e., Grade A, £450 by £18 (14) by £23 to £725; Lecturer, £965 by £25 to £1065.—Application forms and further particulars may be obtained on receipt of a stamped addressed foolscap envelope from THE CHIEF EDUCATION OFFICER, 77/79, GEORGE STREET, OXFORD, to whom completed forms must be returned within ten days of the appearance of this advertisement. L 258

ARTIFICIAL LIMB AND APPLIANCE
CENTRE, EDINBURGH.

Applications are invited from persons qualified in Engineering or allied subjects for post of **TECHNICAL EXAMINER.** The duties call for knowledge of the mechanical side of Motor Cars, Tricycles, Invalid Chairs, and the ability to report. Wages £9 3s. 10d. per week. Superannuation scheme. —Applications in writing giving age, qualifications and experience together with names of two referees to SECRETARY, ASTLEY AINSLIE EDENHALL & ASSOCIATED HOSPITALS BOARD OF MANAGEMENT, GRANGE LOAN, EDINBURGH. L 325

BLACKBURN EDUCATION COMMITTEE.

MUNICIPAL TECHNICAL COLLEGE AND SCHOOL OF ART.
ENGINEERING DEPARTMENT.

Required for 1st September, 1956, or as soon as possible thereafter:—

(A) LECTURER IN MECHANICAL ENGINEERING

Candidates should be graduates in Engineering and corporate members of a Professional Institution, and, in addition, be able to offer the subjects of Theory of Machines, Strength of Materials, Theory of Structures and Thermodynamics up to Higher National Certificate standard. The successful applicant will be required to have had considerable industrial training and some experience of teaching the subjects offered.

(B) ASSISTANT LECTURER (Grade "A" or "B" according to qualifications and experience) to take charge of classes and laboratories for Sheet Metal Work and Welding. This appointment is a new one because of the opening of this section of the new Technical College. The post offers a wide scope for the successful applicant to use initiative in building up the courses. Candidates should have had some industrial and teaching experience and must hold City and Guilds or equivalent technological qualifications in the subjects mentioned.

(C) ASSISTANT LECTURER (Grade "A" or "B" according to qualifications and experience) in the Electrical Engineering Section of the Department. Applicants should hold graduate or equivalent qualifications and will be required to take charge of classes preparing for the City and Guilds Examinations for Radio and Television Servicing Certificate. Ability to assist in teaching the subjects required for Telecommunications and practical experience in Light Current Engineering will be an additional qualification for the post.

Salaries in all cases in accordance with Burnham Scale.

Application forms may be obtained from the CHIEF EDUCATION OFFICER, EDUCATION OFFICES, LIBRARY STREET, BLACKBURN, and when completed must be returned to him as soon as possible. L 333

NOTTINGHAM AND DISTRICT
TECHNICAL COLLEGE.

Principal: D. A. R. CLARK, M.Sc.(Tech.).

Applications are invited for the post of **SENIOR LECTURER FOR PRODUCTION ENGINEERING.**

Salary in accordance with the Burnham Technical Scale: £1065 by £25 to £1215 per annum.

Application forms and further particulars may be obtained from the REGISTRAR, NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE, SHAKESPEARE STREET, NOTTINGHAM, to whom completed forms should be returned not later than Saturday, 12th May, 1956.

F. STEPHENSON,
Clerk to the Joint Education Committee L 334

CENTRAL ELECTRICITY AUTHORITY.
SOUTHERN DIVISION.

FOURTH ASSISTANT ENGINEER (MECHANICAL),
POOLE OIL FIRING SITE.

Applicants should have had experience of the supervision of the mechanical aspects of generating station site work and experience of oil firing or oil handling would be an advantage.

Preference will be given to those with qualifications leading to corporate membership of an appropriate professional institution.

Salary: N.J.B. AX/CX Grade 6, £660-£825.

Special application forms, obtainable from P. D. A. OLIVER, DIVISIONAL SECRETARY, CENTRAL ELECTRICITY HOUSE, 111, HIGH STREET, PORTSMOUTH, should be returned by 9th MAY, 1956. L 342

ESSEX.

THURROCK TECHNICAL COLLEGE, GRAYS.

Required in September, 1956:—

(A) ASSISTANT LECTURER (GRADE "A") for Engineering Workshop Practice and Technology. Knowledge of Welding desirable. Work will be mainly with students preparing for City and Guilds examinations.

(B) ASSISTANT LECTURER (GRADE "A") mainly for Technical Drawing to S.2 level and some Mathematics and Science.

Salary scale for both posts: £450 by £18 to £725 with additions for graduation or equivalent qualification and training. Increments on the scale allowed for teaching service, war/national service and approved industrial experience.

Details and forms (stamped addressed foolscap envelope) from the CLERK TO THE GOVERNORS, DIVISIONAL EDUCATION OFFICE, UPMINSTER COURT, HALL LANE, UPMINSTER. L 343

CENTRAL ELECTRICITY AUTHORITY
require an
ASSISTANT QUANTITY SURVEYOR at Headquarters in London, to assist with work in connection with the building and civil engineering works associated with power station construction, including the co-ordination of methods of preparing Bills of Quantities and contract documents, the critical examination of draft and tender documents, analysis of prices, agreement of rates and assessment of claims. Candidates should have some experience of the preparation of contract documents and settlement of Final Accounts for large industrial building and civil engineering works, preferably associated with modern power station construction, and should have qualifications equivalent to A.R.I.C.S. or the I.Q.S. Salary within N.J.B. Grade 2, £1045-£1395 inclusive.—Applications stating age, qualifications, experience, present position and salary to: D. MOFFAT, DIRECTOR OF ESTABLISHMENTS, WINSLEY STREET, W.1, by 10th May, 1956. Quote Ref. AE/795. L 317

EXAMPLES IN MECHANICAL VIBRATIONS

J. HANNAH, B.Sc. (Eng.) and R. C. STEPHENS, M.Sc. (Eng.), A.MM.I.Mech.E.

Ready in June. This book will be supplementary to the Theory of Machines textbooks in this branch of the subject, and will cover the syllabuses of mechanical vibrations for most examining bodies. Each chapter consists of a review of the subject matter, including the derivation of formulae used, some fully worked examples and a corresponding list of unworked examples, with answers.

160 pages *95 diagrams* *18s. net*

CONCRETE MATERIALS AND PRACTICE

L. J. MURDOCK, M.Sc., Ph.D., A.M.I.C.E.

Second edition

This edition, which has been rewritten and is profusely illustrated, incorporates advances in concrete techniques made in the last few years. *40s. net*

BUILDERS' MATERIALS

B. H. KNIGHT, D.Sc., M.I.C.E., F.R.I.C.S. and R. G. KNIGHT, M.Sc., D.I.C.

Third edition

"A first-class practical book that may be recommended to all who desire to keep abreast of the continual advancement in technical and scientific knowledge of builders' materials."—ROYAL ENGINEERS JOURNAL. *30s. net*

EDWARD ARNOLD

41 Maddox Street, London, W.1.

NATIONAL COAL BOARD.
NORTH EASTERN DIVISION.

Applications are invited for the appointment of
DIVISIONAL METHOD STUDY ENGINEER
at the Divisional Headquarters, Doncaster.

Applicants should have professional engineering qualifications, preferably in coal mining (mining degree and/or First Class Certificate of Competency) although Mechanical, Electrical, Civil and Metalliferous Mining Engineers will be considered. Preference will be given to men who have had considerable managerial experience in a large organisation.

Experience of method study, work study or production engineering is desirable, although not essential, as training will be given to otherwise suitable men lacking this experience. The duties will include the co-ordination and introduction of method study techniques in the Areas, and will involve some travelling.

Salary on appointment will be according to qualifications and experience and will not be less than £1750 per annum.

Applications, giving full details of age, qualifications, experience and positions held should be forwarded to the STAFF DIRECTOR, NATIONAL COAL BOARD, NORTH EASTERN DIVISION, RANMOOR HALL, BELGRAVE ROAD, SHEFFIELD, 10, to arrive not later than the 19th MAY, 1956. L 335

HER MAJESTY'S OVERSEA CIVIL SERVICE.

Applications are invited for the following posts:—
MECHANICAL ENGINEERS,
BRITISH GUIANA.

Duties are (*a*) to keep in good working order all Public Works Department equipment, including road making equipment and sea and river defence machinery; or (*b*) to be in charge of the Land Settlement Department's engineering workshop and of the operation of its machinery pool.

Appointments are pensionable or on contract (3 years) in salary scale £770-£1400. Commencing salary dependent on qualifications and experience. Gratuity of 22½ per cent. of salary payable at six-monthly intervals or on completion of contract. Free passages for officer, wife and three children. Five days leave for each month of resident service.

Candidates should be A.M.I.Mech.E. or be exempt from Sections A and B of the Institution's examination. Candidates for post (*b*) should also have practical experience of mechanical tillage with earth moving and land clearing machinery.

Write to DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, S.W.1, giving age, professional qualifications and practical experience and quote for post (*a*) BCD 112/30/011, and post (*b*) BCD 131/30/02. L 327

GOVERNMENT OF QATAR,
PERSIAN GULF.

STATE ENGINEER'S OFFICE.

Applications are invited for the post of
WATER ENGINEER to take charge under the direction of the State Engineer of a separate Water Department soon to be set up. The Water Engineer will be responsible for the operation and maintenance of four sweet water well areas, brackish water well areas, water pipelines and distribution for all purposes, two distillation plants, eleven drilling rigs and crews and water survey and development in general in conjunction with the Government of Qatar's Water Consultants, Messrs. J. D. & D. M. Watson.

The Water Department will operate its own stores, consumers, clerical and accounting sections and its own laboratory.

QUALIFICATIONS: Candidates must be Corporate Members of the Institution of Civil Engineers or possess an Engineering Degree and be full members of the Institution of Water Engineers. They should be between the ages of 32 and 42 years and have at least ten years' experience in Civil Engineering works connected with water supply and distribution. Experience of water supply in arid areas would be advantageous as would also a knowledge of Arabic.

SALARY: According to Scale E1 starting at Rs.2300/- an Arabic month (£171 12s. 10d.) equivalent to £2122 13s. a Gregorian year, with an annual increment of Rs.100/- a month up to a maximum of Rs.2900.

GRATUITY: Rs.13,500/- (based on one month's pay for each completed year of service) on completion of contract only.

PROBATION: Probationary period of six months during which contract may be terminated at three months' notice by the Government, without stating its reasons.

CONTRACT: A five-year contract subject to successful completion of the probationary period. The employee may terminate the contract at three months' notice only after completing one year's service.

ACCOMMODATION: Free furnished accommodation, fuel, light and water. Married accommodation will be provided in accordance with the rules but in no case before successful completion of probationary period.

LEAVE: Six days per completed month of duty may be taken annually.

FREE TRAVEL: On first journey to Qatar, leave and termination, for applicant, wife and children up to 18 years of age.

GENERAL: The climate is hot for about five months but this is offset by air-conditioning in staff houses and offices. Good climate for the rest of the year. No income tax. Duty car allowance. Free medical and dental treatment.

Applications endorsed "WATER ENGINEER" giving full personal particulars, including age, nationality, religion, education, marital status, qualifications, training, past experience and employment, names of three referees and dated photograph, should be sent IN DUPLICATE to the ADVISER TO THE GOVERNMENT OF QATAR, P.O. BOX 56, DOHA, QATAR, PERSIAN GULF. A further copy with enclosures similarly endorsed should be sent to C. TENNANT, SONS & CO., LTD., 4, COPTHALL AVENUE, LONDON, E.C.2. L 289

NOTTINGHAMSHIRE EDUCATION COMMITTEE.

WEST NOTTINGHAMSHIRE DIVISIONAL EXECUTIVE COMMITTEE.

MANSFIELD TECHNICAL COLLEGE.

Principal: R. F. BEATON, B.Sc.(Eng.), Wh.Sch.

Applications are invited for the following new appointments:—

(A) LECTURER IN MECHANICAL ENGINEERING.
Applicants should be capable of teaching one or more of the following subjects to the level of the Higher National Certificate:—
(1) Thermodynamics.
(2) Strength of Materials.
(3) Theory of Machines.

(B) LECTURER IN PRODUCTION ENGINEERING SUBJECTS.
Applicants should be capable of teaching one or more of the following subjects:—
(1) Metrology and Machine Tools.
(2) Metallurgy.
(3) Workshop Technology to the level of the Higher National Certificate in Mechanical Engineering.

Candidates for posts (A) and (B) should hold graduate or equivalent qualifications and have had appropriate industrial and preferably some teaching experience.

(C) ASSISTANT LECTURER GRADE B IN ENGINEERING SUBJECTS, capable of teaching to the level of the Ordinary National Certificate in Mechanical Engineering with a possibility of some subjects to the Higher National Certificate standard.

Candidates should hold appropriate technical qualifications and should have had experience in industry and/or teaching.

(D) ASSISTANT LECTURER GRADE B IN MECHANICAL AND/OR ELECTRICAL ENGINEERING applied to Mining. The teaching will be largely in the General Certificate and City and Guilds courses for Engineering Apprentices employed by the National Coal Board.

Candidates should hold appropriate technical qualifications and should have had experience in the mining or associated industry. Some teaching experience would be an advantage.

(E) ASSISTANT LECTURERS GRADE A IN THE ENGINEERING DEPARTMENT whose teaching duties will be mainly in the Pre-Senior and Ordinary National Certificate Courses in Mechanical and Electrical Engineering and also in the General Certificate in Mining Courses for the training of Engineering Apprentices employed by the National Coal Board.

Applicants who are prepared to offer English, Mathematics, General Science, and/or Engineering Drawing at the Pre-Senior and S.1 level would also be considered.

Candidates should hold appropriate qualifications and have had suitable industrial and/or teaching experience.

Salaries for the above appointments are in accordance with the Burnham Technical Scale.
Lecturers: £965 by £25 to £1065.
Grade B: £525 by £25 to £820.
Grade A: £450 by £18 to £725.

Additions for Grade B and Grade A Assistant Lecturers may be made for certain qualifications and study training. The position on the scale is determined by previous teaching and industrial experience.

Forms of application may be obtained from (s.a.e.) and should be returned to the DIVISIONAL EDUCATION OFFICER, EDUCATION OFFICE, MARKET PLACE, MANSFIELD. Closing date 30th May, 1956.

J. EDWARD MASON,
Director of Education. L 321

Required by BRITISH RAILWAYS,
STRUCTURAL STEELWORK DRAUGHTSMEN
experienced in design and detail of industrial type buildings, roofs, etc.
Salary range £770 to £910 according to experience and qualifications.
Five-day week.
Residential and other travelling concessions.
Superannuation Fund.
Applications to CHIEF CIVIL ENGINEER, LONDON MIDLAND REGION (Reference 23), EUSTON GROVE, LONDON, N.W.1. L 355

CALDERSTONES HOSPITAL MANAGEMENT COMMITTEE.

CALDERSTONES HOSPITAL, WHALLEY, NEAR BLACKBURN, LANCS.

Applications are invited for the post of
SUPERINTENDENT ENGINEER at the above hospital for mental defectives (2378 beds).

Applicants must hold the Extra First-Class or First-Class Certificate of Competency in Marine Engineering or equivalent Naval Certificate, or the Higher National Diploma/Certificate in Mechanical Engineering (which must include heat and heat engines and carry an endorsement for electrical installations).

The successful applicant will be responsible for the satisfactory operation, maintenance and co-ordination of the engineering services and activities of the hospital, including both mechanical and electrical. He will be required to supervise the carrying out of works of engineering maintenance and will be responsible for keeping all records needed for the effective and efficient control of the engineering staff, plant, services and equipment. He will be required to live in the house provided.

Salary scale £930 by £30(5) to £1080 per annum. Whitley Council Conditions of Service. Appointment subject to medical examination.

Application forms obtainable from the GROUP SECRETARY, to be returned not later than 9 a.m. on Monday, 14th May, 1956. L 279

THE POLYTECHNIC,
309, REGENT STREET, LONDON, W.1.

CIVIL AND MECHANICAL ENGINEERING DEPARTMENT.

Applications are invited for a
FULL-TIME POST OF ASSISTANT GRADE B IN CIVIL OR MECHANICAL ENGINEERING.

The salary scale for Graduates commences at £585 per annum, rising by annual increments of £25 to £880, plus London allowance of £36 or £48 per annum with additional allowances for a good honours degree and training where applicable. The commencing salary may include increments for previous teaching and professional service.

Further particulars and a form of application, which should be returned not later than 14th May, may be obtained by sending a stamped addressed foolscap envelope to THE UNDERSIGNED.

J. C. JONES,
Director of Education. L 318

ASSISTANT RESIDENT ENGINEER (BRIDGES) required in Manchester area. Experienced in design of steel and iron bridges and roofs and supervision of steel work repair. Organising ability essential. Salary £795-£860.

Superannuation Scheme.
Five-day week.
Residential and staff travelling facilities available.

Apply in writing to CHIEF CIVIL ENGINEER, (REF. 24), LONDON MIDLAND REGION, BRITISH RAILWAYS, EUSTON GROVE, LONDON, N.W.1. L 354

CENTRAL ELECTRICITY AUTHORITY,
LONDON DIVISION.

THIRD ASSISTANT ENGINEERS. (OPERATIONAL RESEARCH).
DIVISIONAL HEADQUARTERS.

ENGINEERS (2) required for Operational Research Section. Training will be given. Higher National Certificate essential. These positions offer interesting work to young engineers with a flair for investigation who are interested in the problems associated with power generation. N.J.B. conditions of service with salary in scale £850 10s.-£1085 (revised scale). Superannuation Fund.—Applications, quoting vacancy number 56/321, should be made to DIVISIONAL SECRETARY, CENTRAL ELECTRICITY AUTHORITY, LONDON DIVISION, P.O. BOX 136, GENERATION HOUSE, GREAT PORTLAND STREET, W.1. Closing date 11th May, 1956. L 348

VACANCIES
in
SOUTH AFRICA

ELECTRICITY SUPPLY COMMISSION
of the Union of South Africa require:—

CONTROL ENGINEERS
SHIFT ENGINEERS
JUNIOR SHIFT ENGINEERS
DISTRICT ASSISTANTS
SWITCHBOARD ATTENDANTS
ENGINEERING ASSISTANTS
for Mechanical Test Department
PROTECTION ENGINEERS & METER ENGINEERS
for Electrical Test Department
POWER STATION CHEMISTS

Good salaries and allowances and generous service conditions are offered and all positions afford good prospects of advancement. Rail and sea passages will be provided for selected applicants, their wives and minor children, subject to agreement to serve the Commission for at least three years.—For further particulars apply in writing to the LONDON REPRESENTATIVE, ELECTRICITY SUPPLY COMMISSION, 723, THE ADELPHI, JOHN ADAM STREET, LONDON, W.C.2. L 353

NORTHAMPTON COUNTY BOROUGH EDUCATION COMMITTEE.

NORTHAMPTON COLLEGE OF TECHNOLOGY

Principal: E. JEWITT, B.Sc., M.I.E.E.

Applications are invited for appointment from 1st September, 1956, for an
ASSISTANT, GRADE B, TO TEACH MACHINE SHOP ENGINEERING subjects up to the standard of the Final Examinations of the City and Guilds of London Institute in Machine Shop Engineering. Applicants should possess suitable technical qualifications, together with industrial experience. Ability to assist with O.N.C. and H.N.C. courses in Mechanical Engineering would be added recommendations.

Salary in accordance with the Burnham Technical Scales.

Application forms, which should be returned by 7th May together with further particulars, can be obtained from the undersigned: H. A. SKERRETT, CHIEF EDUCATION OFFICER, "SPRINGFIELD," CLIFTONVILLE, NORTHAMPTON. L 344

BRITISH EUROPEAN AIRWAYS require
ENGINEER at Head Office to advise Property Manager on all aspects of building services, including design and supervision of new works and maintenance existing installations. Sound knowledge heating, ventilating, air-conditioning systems and, preferably, electrical installations. Experience high pressure hot-water systems an advantage. Corporate membership of I.H.V.E. or I.Mech.E. essential. Salary range £975-£1375 p.a., depending on experience. Pension Scheme.—Full details to HEAD OFFICE, PERSONNEL OFFICER, B.E.A., KEYLINE HOUSE, RUISLIP, MIDDLESEX. L 330

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH (GENEVA) require
A SITE AND MAINTENANCE ENGINEER
for their research laboratories at Geneva, Switzerland. He will have responsibility initially for the co-ordination and supervision of the construction of an extensive site and installation of plant and machinery, and later for the operation and maintenance of the site and plant. Applicants should have a university or equivalent technical degree, preferably in electrical engineering, and extensive experience of comparable engineering work including heating systems, power stations, water installations, cranes, etc. A sound knowledge of French is desirable. Applicants must be able to collaborate with European staff. Salary according to experience and qualifications within the range Sw.fr.27,780-33,480 (approx. £2315-£2790) (tax free) plus family allowances. Good leave and social security arrangements.—Write to MINISTRY OF LABOUR AND NATIONAL SERVICE, ALMACK HOUSE, 26-28, KING STREET, LONDON, S.W.1, for application forms and further information quoting A12/590/CERN/8WI. L 319

LONDON ELECTRICITY BOARD.

CIVIL/STRUCTURAL ENGINEERING ASSISTANTS AND DRAUGHTSMEN.

Applications are invited for the above positions in the Construction Branch of the Chief Engineer's Department in Central London.

Conditions of service are in accordance with the National Joint Board agreement, Schedule "D," and salaries are inclusive of London Allowance.

Applicants for the positions of Assistants should have experience in the design and detailing of reinforced concrete for foundations, framed buildings, etc., or in the design and detailing of structural steelwork for buildings, etc. Salary within Grade 5 = £735 to £840 per annum.

Applicants for the positions of Draughtsmen should have experience in the preparation of drawingk for either reinforced concrete or structural steelworks or building work. Salary within Grade 6 = £588 to £714 per annum.

Application forms obtainable from PERSONNEL OFFICER, 46, NEW BROAD STREET, LONDON, E.C.2. Please quote ref.: PER/V/2003/FF. L 85

CITY OF NOTTINGHAM.

ASSISTANT QUANTITY SURVEYOR, GRADE APT. V (£795 to £970 per annum).

Applications are invited for the above position in the City Engineer's Department.

Applicants should be Associates of the Royal Institution of Chartered Surveyors, or have extensive professional experience. The person appointed will be required to be responsible for all the Quantity Surveying work on individual major contracts. Commencing salary will be according to experience.

Housing accommodation is available.

Applications on forms to be obtained from R. M. FINCH, O.B.E., M.I.C.E., CITY ENGINEER AND SURVEYOR, GUILDHALL, are to be returned to him ten days after the appearance of this advertisement.

R. M. FINCH,
CITY ENGINEER AND SURVEYOR.
L 196

COUNTY BOROUGH OF DONCASTER.

ENGINEERING ASSISTANT.

Applications are invited for the appointment of an **ENGINEERING ASSISTANT (MECHANICAL)** to supervise the installations, maintenance and repairs of mechanical plant and equipment at the Sewage Disposal Works, Public Baths, Water and Highways Departments, at a salary to be fixed according to the candidates abilities, experience and qualifications.

Applications stating age, qualifications (if any), present appointment and salary, previous appointments and full details of experience, together with the names and addresses of two referees, should be sent to the Borough Engineer and Surveyor, 2, Priory Place, Doncaster, Yorks, on or before Saturday, 28th April, 1956.

Candidates must state, in writing, whether they are related to any member or senior officer of the Council.

H. R. WORMALD,
TOWN CLERK.
1, PRIORY PLACE,
DONCASTER. L 109

THE BERMUDA ELECTRIC LIGHT COMPANY, LTD.

ASSISTANT POWER STATION SUPERINTENDENT.

Applications are invited for the above post in the Company's power station which contains 18,000 kW of diesel engine plant. Candidates should be between 25 and 35 years of age, be A.M.I.Mech.E. or possess equivalent qualifications and experienced in oil engine operation and maintenance. There are good opportunities of advancement for an engineer willing to make his home in Bermuda.

Applications, giving full details of qualifications, etc., should be addressed to MESSRS. MACKNESS & SHIPLEY, PARLIAMENT MANSIONS, ABBEY ORCHARD STREET, WESTMINSTER, S.W.1, from whom further particulars can be obtained. L 107

Classified Advertisements continued on Page 6

APPOINTMENTS OPEN.

THE ENGAGEMENT OF PERSONS answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order 1952.

It is advisable when sending testimonials to forward copies and NOT originals.

DESIGNER DRAUGHTSMEN, SEVERAL JUNIOR AND SENIOR DRAUGHTSMEN required, with mechanical and structural experience, by a well-known firm manufacturing steelworks, coke oven and mechanical handling plant. Five-day week. Excellent office conditions. Staff Pension Scheme.—Write stating age, experience and salary required to—CHIEF DRAUGHTSMAN (C), THE WELLMAN SMITH OWEN ENGINEERING CORPORATION, LTD., DARLASTON, SOUTH STAFFS. L 94

Vacancies exist in the Works Engineer's Department of a large Company in East London for

PERSONNEL CAPABLE OF DRAWING AND PLANNING LAYOUTS

for both Machine and Assembly Shops from information supplied by Time Study Departments, also experience in Ventilation and Extraction Systems, Palletisation and Mechanical Handling of Stores, etc. Age between 30 and 40. A salary of up to £750 will be paid to the selected candidates.—Please write, giving details of experience to BOX L 144, Offices of ENGINEERING.

AERO ENGINE CONTROL SYSTEM.

ENGINEERS are required for a newly formed department dealing with various theoretical aspects of aero engine control problems. Experience of screw mechanism analysis and for gas turbine engine performance investigation is desirable.—Applications quoting END to TECHNICAL PERSONNEL MANAGER, ARMSTRONG SIDDELEY MOTORS, COVENTRY. G 658

ROCKETS—TEST PLANT DESIGN AND DEVELOPMENT. ARMSTRONG SIDDELEY MOTORS require

ENGINEERS with a Degree or H.N.C. to design and develop Rocket propulsion experimental test equipment. This young division with its future is a worthwhile field both for interest and prospects.—Applications, quoting RTP, to TECHNICAL PERSONNEL MANAGER, ARMSTRONG SIDDELEY MOTORS, COVENTRY. G 659

MECHANICAL ENGINEER required with first-class experience in diesel and/or gearing work. Sound qualifications essential, including good drawing office experience. 25 miles N.W. London. Superannuable. Commencing salary £800 per annum —Write with full details BOX A.C.18415, SAMSON CLARKS, 57-61, MORTIMER STREET, W.1. L 265

RESIDENT ENGINEER

to supervise construction of large Iron and Steelworks in India. Considerable similar experience required. Good salary and conditions of employment to the right man.—Apply in writing giving full particulars of age, education, training and practical experience, stating salary expected and when available to BOX L 251, Offices of ENGINEERING.

Also required for same job:—

ONE CIVIL ENGINEER
ONE MECHANICAL ENGINEER
ONE ELECTRICIAN

SENIOR MECHANICAL ENGINEERING ASSISTANT required by London Consulting Engineers. Drawing Office experience also knowledge of marine and/or mechanical engineering essential. Knowledge of dock and harbour plant an advantage.—Write stating age, training and experience to BOX L 304, Offices of ENGINEERING.

JUNIOR DRAUGHTSMEN required, O.N.C. standard, experience in general engineering and/or sheet metal fabrications for work on specialised equipment for the Dairy, Brewery and Chemical Industries. Salary commensurate with experience.—BOX L 284, Offices of ENGINEERING.

A large works in the North West invites applications for the appointment of

MECHANICAL ENGINEER.

Graduate engineers preferred. Age group 30-40. Salary £1500-£1800 depending on qualifications and experience. Membership of a staff pension and life assurance scheme is obligatory and an assisted house purchase scheme is in operation.

Applications with details of experience and qualifications to BOX L 312, Offices of ENGINEERING.

A leading Electrical Engineering Company is seeking **A CHIEF PRODUCTION ENGINEER** for its Midlands factory. This is a senior appointment involving responsibility for the complete factory Production Engineering functions including Processing, Ratefixing and Jig and Tool Design on medium and heavy type mechanical electrical products. Only men with wide experience of Production Engineering in machining, fitting and fabrication and with the highest qualities of drive and managerial ability need apply for this important post. The appointment is situated in a pleasant Midland town and will carry a starting salary commensurate with its senior status plus bonus and non-contributory superannuation.—Please apply to BOX L 241, Offices of ENGINEERING.

TO COPE WITH RAPIDLY EXPANDING HOME AND EXPORT DRIVE,

CROFTS (ENGINEERS) LIMITED, THORNBURY, BRADFORD, YORKS,

URGENTLY REQUIRE

DRAUGHTSMEN

Salary, bonus and prospects are excellent for men with necessary experience and qualifications.

Applicants should have good general Engineering experience. Knowledge of Gear Units, Clutches and Transmission Equipment an advantage. Educated preferably to Higher National standard.

The positions are permanent and superannuated.

Applications to be made in writing to PERSONNEL MANAGER and endorsed D.O.3.

Travelling expenses for interviews will be refunded and all matters relating to the applications will be regarded as strictly confidential. L 270

IMPERIAL CHEMICAL INDUSTRIES LIMITED, ALKALI DIVISION, WINNINGTON, NORTHWICH, CHESHIRE.

EXPERIENCED DESIGN DRAUGHTSMEN.

Vacancies exist for experienced draughtsmen for employment as Assistant Technical Officers in expanding Instrument Design Sections engaged on large-scale instrumentation projects for chemical processes and power plants. Minimum qualifications are (*a*) an approved apprenticeship to an appropriate trade; (*b*) Higher National Certificate. Candidates must have sound practical and theoretical knowledge of process control techniques using pneumatic and electronic systems, and the aptitude for close co-operation with other engineering design teams and with contractors' and plant personnel. Age 25-40.

Appointments are to the permanent staff, five-day week, with good salaries, first class working conditions and recreational facilities. Contributory Pension Fund and Profit-Sharing Schemes. Married men can receive limited assistance with removal expenses.—Write for official application form to STAFF MANAGER, quoting reference GES/DESN. L 346

ALFRED BIRD & SONS, LIMITED, Manufacturers of Food Products, invite applications from

QUALIFIED ENGINEERS for the position of Project Engineer in the Design and Development area of the Engineering Department.

This position is directly responsible to the Chief Engineer and provides a wide field of mechanical and chemical engineering work, connected with the modernisation and extension of production facilities.

Applicants, aged 30/40 years should, preferably, possess a good Engineering Degree, but Associate Members of one of the Senior Engineering Institutions will be considered if this qualification is backed by suitable practical experience.

The appointment calls for a man with good workshop experience and a flair for development work coupled with down-to-earth practical engineering sense, and, preferably, with some experience in the Food Trade.

Commencing salary offered will be in the range of £750-£1250 per annum.

The Company runs a Pension and Life Assurance Scheme, and operates a five-day week.

Apply giving full details, in confidence, to the PERSONNEL MANAGER, ALFRED BIRD & SONS, LIMITED, DEVONSHIRE WORKS, DERITEND, BIRMINGHAM, 12. L 291

BRISTOL AERO-ENGINES LIMITED

★

Engineers and Physicists

for design and development work on test plant

1. ELECTRONIC ENGINEERS,

with degree qualifications of A.M.I.E.E. or equivalent, and experience in industrial electronics for control and measurement. Work in this field will cover electronic simulators, high speed sampling systems, data reduction, instrument servo mechanisms, vibration and strain measurements, etc., applied to the testing of Aero-Engines, Ramjets and associated equipment.

2. PHYSICISTS,

with degree or equivalent, and practical experience of industrial physics with particular reference to noise measurement and suppression; option; vibration, fluid flow and temperature measurements associated with Aero-Engine performance testing and plant.

3. PLANT ENGINEERS,

with degree A.M.I.Mech.E. or H.N.C. with experience of plant and equipment design for Aero-Engines, Ramjets and accessories. This covers subjects such as transmission of power through high speed shafts, gearing, bearings, high velocity high pressure fluid flows, plant fuel pumps and systems, noise and vibration insulation, thrust and power measurement.

4. STRESS ENGINEERS,

with degree or A.M.I.Mech.E. or H.N.C. for stress calculations and design work associated with Aero-Engine and Ramjet Test Plant. The work covers problems associated with transmission of large powers through high speed shafts, gearing, bearings, high velocity high pressure air ducting, engine mountings, etc.

5. GRADUATES,

with degree, as Senior Assistants to the above posts.

Apply in writing, quoting 77/JEG, giving full particulars and vacancy in which you are interested to the Personnel Manager, Bristol Aero-Engines Ltd., Filton House, Bristol.

BRISTOL

L 350

FERODO LIMITED, manufacturers of friction materials, invite applications for the following positions on the Test House Staff:—

(1) DRAUGHTSMAN-DESIGNER to design new test machines and new devices for the measurement of friction thereon. Candidates must have drawing office experience in design and stress work and should have at least an Ordinary National Certificate, and preferably a Higher National Certificate in mechanical engineering or equivalent. Ref. No. 5033/1.

(2) A TECHNICAL ASSISTANT to carry out investigations on the performance of test machine leading to the improvement of machines, testing procedures and methods of recording; also to organise special tests on proprietary brakes, clutches, overdrives, etc. Candidates should have at least an Ordinary National Certificate in Mechanical Engineering. Ref. No. 5033/2.

(3) A TECHNICAL ASSISTANT to divide his energies, according to varying priority, between the two types of work specified above, i.e., part design and part experimental work. Candidates should have at least an Ordinary National Certificate in Mechanical Engineering. Ref. No. 5033/3.

These are staff positions at attractive salaries and carry a pension. Applications, quoting the appropriate reference number, and giving full personal details including present salary, should be submitted in confidence to the PERSONNEL MANAGER. L 294

WANTED

DRAUGHTSMEN to design in aluminium for sales development. Must possess Higher National Certificate in Mechanical Engineering. Location Banbury. Good working conditions and pleasant surroundings. Attractive starting salaries offered up to £800 p.a. with prospects of promotion from drawing board. Pension plan in operation. Send brief details of qualifications and experience to NORTHERN ALUMINIUM CO., LTD., BUSH HOUSE, ALDWYCH, LONDON, W.C.2. G 562

Leading manufacturers of container closures in the Midlands have a number of vacancies for ambitious **DESIGN DRAUGHTSMEN** preferably with some experience in this or a similar sphere. Interesting work with excellent salary and every opportunity for promotion to senior position in a rapidly growing organisation. Write in confidence with details of experience, positions held, salary required, to P.A. METAL CLOSURES LIMITED, BROMFORD LANE, WEST BROMWICH. G 627

STRUCTURAL ENGINEER with wide experience of the design and detailing of all types of steel structures and with administrative experience required to act as deputy to the Chief Engineer by large firm of London Consultants. The firm is expanding and the vacancy offers excellent opportunities for the right type of man.—Write in confidence giving details of previous experience and salary required to BOX No. 355, GLOVERS ADVERTISING LTD., 351, OXFORD STREET, LONDON, W.1. G 635

West End London Consulting Engineers require now **SEVERAL SENIOR AND JUNIOR ENGINEER DRAUGHTSMEN** to prepare designs, contract drawings, specifications, etc., for heating, ventilating, boiler plant and allied mechanical services. Interesting work for factories, office blocks, hospitals, colleges, schools, etc. Opportunity for experienced men with initiative. Five-day week. One week's spring holiday in addition to usual summer two weeks. Bonus and optional superannuation scheme.—Write stating age, experience, qualifications and salary required, BOX G 538, Offices of ENGINEERING.

SENIOR CRANE DRAUGHTSMAN required with experience in the design of electric overhead travelling cranes and jib cranes. Pension scheme. House available for successful applicant.—Apply in writing to JOHN SMITH (KEIGHLEY), LTD., P.O. BOX No. 21, KEIGHLEY. L 349

AN ASSISTANT MECHANICAL ENGINEER is required for investigating the many engineering problems encountered in an integrated iron and steel works.

Applicants should be Graduates between 23 and 30 years of age.

Applications to: THE CHIEF ENGINEER, WORKINGTON IRON & STEEL COMPANY, MOSS BAY, WORKINGTON, CUMBERLAND. MARKED PERSONAL. L 352

SENIOR DRAUGHTSMAN with design experience in Blast Furnace and Foundry Plants, mechanical handling plant and steel structures. Superannuated post.—Applications, which will be treated in confidence, should state age, technical qualifications and full details of previous experience in chronological order and be addressed to the STAFFING OFFICER, THE STANTON IRONWORKS CO., LTD., Nr. NOTTINGHAM. L 351

SENIOR DRAUGHTSMAN required. Works Engineer's Department, DAVEY, PAXMAN & CO., LTD., GENERAL ENGINEERS, COLCHESTER, ESSEX. Applicants should have knowledge building construction and design. Some mechanical experience advantageous but not essential. Excellent working conditions, good welfare and canteen facilities. Superannuation and Staff Assurance Scheme.—Apply in writing, stating age, experience and qualifications, to PERSONNEL MANAGER. L 341

MULLARD BLACKBURN WORKS, LTD., require a

SCIENCE GRADUATE OR EQUIVALENT

for work on problems arising in the mass-production of radio valves. The work is varied and interesting, and offers considerable scope to an applicant with DRIVE and the ABILITY TO MIX with people at all levels.—Apply in writing giving full details of career to date, age, education, etc., to the PLANT PERSONNEL OFFICER, MULLARD BLACKBURN WORKS, LTD., PHILIPS ROAD, BLACKBURN, LANCS., quoting ref. V/L. L 345

Large steam engineering company in North Midlands requires

GRADUATE ENGINEERS

to work on own initiative on wide variety of technical probems during development and subsequent service associated with the supply of equipment to Nuclear and conventional power plants, industrial, marine, and all steam users. Training will be given before responsibility is delegated. Applicants, who should be between 23 and 30 years of age, and must have completed, or be exempt from, national service, must have served an apprenticeship in mechanical engineering. The posts offered are permanent and progressive and will carry salaries appropriate to the responsibility. A pension scheme is in force. All applications, which will be treated in strict confidence, to BOX L 151, Offices of ENGINEERING.

GRADUATE ENGINEERS FOR CONSTRUCTION

Applications are invited for the following position with Major Oil Company Middle East.

(1) **ENGINEERING ASSISTANT TO CONSTRUCTION SUPERINTENDENT (CIVIL OR MECHANICAL ENGINEER)** with over five years experience field engineer construction process plant, industrial and general building projects. Familiar field organisational problems and with good working knowledge general construction and equipment. Age 30-40. Commencing salary £1580 p.a. up according experience, etc.

(2) **FIELD ENGINEERS (4) (CIVIL OR MECHANICAL)** with over two years experience in either general building projects such as housing, public buildings and utility installations or in oil refinery or chemical process plant installation and utilities. Must be familiar with job planning, scheduling and general construction techniques. Age about 30. Commencing salary £1245 p.a.

In addition to salaries quoted, free air conditioned accommodation and adequate living allowance provided with medical attention, kit allowance, pension plan and paid home and local leaves.—Apply (quoting CON) to BOX G 647, Offices of ENGINEERING.

PETER BROTHERHOOD LIMITED

are desirous of appointing an

EXPERIENCED MAN AS WORKS ENGINEER

who would be responsible to the Board.

The firm are general Engineers manufacturing a large variety of high-class products, and candidates for this appointment should hold a University degree in Engineering and should have had several years' experience in mechanical engineering.

The position offers to the right man prospects of advancement to the highest levels.

None but first-class men need apply as the salary offered will be a liberal one.

Applications, giving age, qualifications and details of experience should be addressed to the SECRETARY, PETER BROTHERHOOD LTD., PETERBOROUGH. K 996

LEADING MANAGEMENT CONSULTANTS have several vacancies for

QUALIFIED ENGINEERS WITH EXECUTIVE EXPERIENCE and with initiative to act as Consultants after training. Age not over 40. Salary scale, £1500 to over £2200 p.a., with considerable further prospects to exceptional men. Superannuation and expense allowances.—Full details of qualifications and experience to BOX K 998, Offices of ENGINEERING.

DESIGN DRAUGHTSMEN. THE BRITISH DRUG HOUSES LTD. invite applications from suitably qualified men for interesting work in their Engineers' Drawing Office, on special machines and plant layouts for the Light Chemical Industry. Higher National Certificate in Mechanical Engineering and previous experience in this industry desirable but not essential. Men of mature age with suitable training and experience would be considered. Five-day week. Pension and Profit Sharing Schemes.—Write, stating age, experience and salary required, to STAFF MANAGER (REF.: B 8945), GRAHAM STREET, CITY ROAD, N.1. K 985

SENIOR DRAUGHTSMAN required, London area. Heavy Mechanical Engineering experience essential, knowledge of gearing an advantage.—Write, stating age and salary required and giving full details of experience, to BOX L 35, Offices of ENGINEERING.

METROPOLITAN-VICKERS ELECTRICAL CO., LTD.,

have the following vacancies in their Research Department :—

HONOURS GRADUATES IN ENGINEERING OR PHYSICS

with post-graduate or industrial research experience to work on—Heat Transfer, with particular reference to industrial nuclear energy, Wear and Lubrication.

The work is of considerable scientific interest and successful applicants of suitable ability would be encouraged to form and lead their own experimental teams. The posts provide excellent opportunities for men with originality and an aptitude for experimental work to establish themselves in these important branches of applied research. Age limits 28-35 years.

Vacancies also exist for younger men interested in original experimental work in these and other fields which include :—

Experimental Stress Analysis.
Failure of Metals under Compound Stress.
Physics of Metal Surfaces.
Metal Cutting Research.

For these vacancies previous research experience, though desirable, is not essential.

MECHANICAL ENGINEERS.

Ordinary degree, H.N.C., or similar qualifications for experimental work and the development of experimental equipment in the Mechanical, Thermodynamics and Metal Cutting Laboratories. Candidates must have had practical workshop experience. Some knowledge of experimental work would be an advantage. Age limits, 25-30 years.

MECHANICAL ENGINEER OR METALLURGIST,

preferably graduate, to organise the preparation and periodical review of data sheets on the mechanical properties of engineering materials. The work would involve maintaining a running survey of available mechanical test data (including creep and fatigue) both from published sources and from the Company's own mechanical testing laboratories, and might include some experimental work. Research experience is not essential, but a knowledge of mechanical testing and the application of test data to engineering design would be an advantage.

TECHNICAL ASSISTANTS,

O.N.C. (Mechanical), or similar standard, for general duties in the mechanical testing laboratories. Practical workshop experience is essential and some laboratory experience would be an advantage. Preference would be given to applicants intending to study for higher technical qualifications. Age limits, 23-30 years.

These posts are permanent and pensionable, and in all cases salary would be in accordance with age, qualifications and experience.

Apply for Application Form, quoting reference "W.4," to :—

PERSONNEL MANAGER,
METROPOLITAN - VICKERS ELECTRICAL CO., LTD.,
TRAFFORD PARK,
MANCHESTER 17. L 201

REGULATING SYSTEMS ENGINEERS.

Vacancies exist on the staff of an Engineering Department of the BRITISH THOMSON-HOUSTON CO., LTD., which is engaged in designing industrial regulating systems and servomechanisms. An electrical engineering degree, or equivalent academic qualification, is essential and some experience of feed-back control systems is desirable. The Department handles applications in a wide variety of industries and some specialised knowledge of a particular industry might be an advantage although this is not a requirement.

Applications should be in the Applicant's own handwriting, and should state age, qualifications, training and experience.

Apply: MANAGER, INDUSTRIAL ENGINEERING DEPARTMENT, THE BRITISH THOMSON-HOUSTON CO. LTD., RUGBY. L 1

Rocket Division of Armstrong Siddeley Motors has really good vacancies for

DESIGNERS AND DRAUGHTSMEN intent on furthering their career in this new branch of propulsion. Applicants must have had minimum of three years drawing office experience and preferably hold at least a Higher National Certificate in Mechanical Engineering. Drawing office experience, however, is preferable to academic qualifications. Due to new projects and consequent expansion of departments prospects for men of the right calibre are unusually good. This is a fine opportunity to enter on the ground floor of new and fascinating work with far reaching implications. Initial salary range £13 10s. to £16 10s. per week.—Apply for a personal interview with our Chief Designer, Rocket Division by writing to TECHNICAL PERSONNEL MANAGER, ARMSTRONG SIDDELEY MOTORS, COVENTRY, quoting reference RD/DD. G 631

IMPERIAL CHEMICAL INDUSTRIES LIMITED.

ALKALI DIVISION.

WINNINGTON, NORTHWICH, CHESHIRE.

STRUCTURAL AND CIVIL ENGINEERING DESIGNERS.

Vacancies exist in our Civil Engineering Department for Assistant Technical Officers to work as structural and civil engineering designers. Applicants age 25-40 should possess H.N.C. and have had experience either in structural work or in reinforced concrete and general building work.

Appointments are to the permanent Staff, five-day week, with good salaries, first class working conditions and recreational facilities. Contributory Pension Fund and Profit-Sharing Schemes. Married men can receive limited assistance with removal expenses.—Write for official application form to STAFF MANAGER quoting reference GES/STRUCT. L 216

NEW RESEARCH LABORATORY

IMPORTANT APPOINTMENTS FOR ENGINEERS.

POWERS-SAMAS ACCOUNTING MACHINES, LTD. (one of the Vickers Group of Companies) is expanding the resources of its Research Division for the development of electronic data processing equipment, punched-card machines and allied devices. A new Research Laboratory is under construction at Caterham, Surrey—and until its completion the staff appointed will work at existing establishments in Croydon and Crayford, Kent.

Appointments, which will be at competitive salaries, and in accordance with qualifications and experience, are offered to :—

1. Engineers with graduate or equivalent qualifications for research and development work on small complex mechanisms associated with punched card accounting systems.

2. Engineers with a sound technical background and ability to analyse complex mechanisms and to effect practical and economic improvement.

Applications, with details of experience and qualifications, should be sent to THE PERSONNEL MANAGER, POWERS-SAMAS ACCOUNTING MACHINES, LTD., CROYDON. G 629

CHIEF DESIGNER required by a well established heavy General Engineering Company with an international reputation in the manufacture of mining plant, water turbines and special engineering projects. Applicants must possess first-class academic qualifications and proven administrative ability backed by a wide practical experience of research, design and production. An appropriate salary with superannuation will be paid. Applications with full details, which will be dealt with in strict confidence should be addressed to BOX No. 131, R. ANDERSON AND CO., 14, WILLIAM IV, STREET, LONDON, W.C.2. L 118

BILLINGHAM ICI DIVISION

Vacancies for

MECHANICAL ENGINEERS

This division of I.C.I. Limited offers outstanding opportunities for University Graduates in Mechanical Engineering whose training and experience will enable them to take their place in an expanding industry requiring versatility and technical competence. Individual careers are carefully planned for young engineers to give them a wide technical experience and early responsibility on the management side.

Billingham annually produces over 2,000,000 tons of heavy chemicals, among them being ammonia, fertilisers, sulphuric acid, urea, methanol, petrol, and many organic chemicals derived from petroleum. Each new product presents its own engineering problems which have to be solved before full-scale production can begin. The Division therefore maintains its own Engineering Research Department and has a very extensive design organisation. On the production side process engineering provides an excellent opportunity for the engineer who wishes to combine his technical interests with those of management.

These appointments are permanent and pensionable and carry attractive salaries. There is also a profit-sharing scheme in operation. Assistance can be given towards house purchase and removal expenses in the case of married men.

Write, giving brief details of age, qualifications and experience, to the Staff Manager, Imperial Chemical Industries Limited, Billingham Division, Billingham, Co. Durham, quoting reference A.5 L 261

A.E.C. LIMITED require

DETAIL DRAUGHTSMEN. Experience of the motor industry an advantage. Modern offices and equipment, excellent opportunities for progress. Good salary offered, five-day week, pension scheme and canteen facilities.—Applications in writing, giving age, experience and salary required to STAFF RECORDS OFFICE, WINDMILL LANE, SOUTHALL, MIDDLESEX. K 877

A MECHANICAL ENGINEER is required by the WESTINGHOUSE BRAKE & SIGNAL CO. for work in connection with design, development and testing of mechanical, pneumatic and electro-mechanical equipment for Railway Signalling. Applicants are not expected to have had experience of this particular type of work, but some experience of design of mechanical equipment is desirable. The minimum qualification is H.N.C. in mechanical engineering. Salary will be in accordance with age, qualifications and experience. The Company operates a Pension Scheme, and a 5-day week. Write giving details of age, qualifications and experience, to PERSONNEL SUPERINTENDENT, WESTINGHOUSE BRAKE & SIGNAL CO., LTD., CHIPPENHAM, WILTS, quoting reference No. EQUIP/N/O. L 121

PLANT ENGINEER 25-35 YEARS, required for progressive Company of Engineers and Founders. Group Pension Scheme and Employees Share Holding Scheme operated. Applications in writing to KENT ALLOYS LIMITED, TEMPLE MANOR WORKS, ROCHESTER, KENT. L 124

DRAUGHTSMEN required for detail work on printing machinery. Good opportunity for young men to specialise. Excellent conditions, pension scheme, canteen. Please send brief particulars to H.T.B. LTD., BLACKHORSE LANE, WALTHAMSTOW, E.17. L 24

STRUCTURAL ENGINEER required by London firm of Consultants to take charge of their steel design office. Candidates must have a comprehensive knowledge of all types of structural steelwork both designing and detailing and should preferably have had some works experience. Applicants should be Corporate Members of one of the senior professional Institutions or hold similar Degrees. The post is a permanent one and there is a Staff Pension Scheme.—Please reply in confidence to BOX NO. 389, GLOVERS ADVERTISING, LTD., 351, OXFORD STREET, W.1. G 643

DRAUGHTSMAN required for Engineering Department of modern Tar Distillery. Applicants should be of at least O.N.C. Standard with General Engineering experience, preferably including plant layout and piping. Varied and interesting work, including some site work. Pension scheme. Salary up to £750 per year.—Apply to CHIEF ENGINEER, LANCASHIRE TAR DISTILLERS LIMITED, LIVERPOOL ROAD, CADISHEAD, NR. MANCHESTER. L 36

Classified Advertisements continued on Page 9

SITE AGENTS.

Required for Building and Civil Engineering contracts in various parts of the country. Applicants will be expected to have sound supervisory experience on a wide variety of contract work. Professional qualifications are required for those seeking senior Civil Engineering appointments. Full mobility essential. Age 30-50. Salary commensurate with experience and qualifications.

The Company has an established policy of employment security and men who prove themselves can expect advancement and permanent pensioned employment.

Applications in writing to:

PERSONNEL MANAGER (SA.4), JOHN LAING & SON LIMITED,
BUILDING AND CIVIL ENGINEERING CONTRACTORS,
LONDON, N.W.7. L 27

ENGINEER/DRAUGHTSMAN required for Consulting Engineers office. Man with iron and steel works experience preferred, but not essential.—Write stating age, experience and salary required to JOHN MILES & PARTNERS (LONDON), LTD., 76, CANNON STREET, E.C.4. L 139

DRAUGHTSMAN DESIGNERS required for UNILEVER LTD., LONDON OFFICE. Workshop trained. At least O.N.C. standard for design and planned layout of factory plant. Candidates should have experience in general mechanical engineering. Pension Scheme and canteen.—Send particulars of age, training and experience in full to: PERSONNEL DIVISION (WAD 114), UNILEVER LTD., UNILEVER HOUSE, LONDON, E.C.4. L 3

DRAUGHTSMEN DESIGNERS AND DETAILERS, Senior and Junior required. Experience in Steel Bridges and Structures. Important and interesting work. Permanent positions. High salary. Five-day week. Pension scheme.—Apply stating particulars of experience to THE CLEVELAND BRIDGE AND ENGINEERING CO., LTD., 123, PALL MALL, LONDON, S.W.1. L 180

A FOREMAN, AGE BETWEEN 40/45 YEARS, is required for an old established Ingot Mould Foundry. The applicant should be fully conversant with modern production methods and in the use of sand slingers. The successful applicant would be expected to take full charge of the ingot mould section. All applications will be treated in strict confidence.—Details of age and experience to BOX L 223, Offices of ENGINEERING.

Required by Consulting Engineers:

(A) CHIEF RESIDENT ENGINEER for overall supervision of very extensive works to be constructed in British West Africa, including railways, roads, tunnels, bridges, power houses, conveyors, jetties, water supply, housing, hospital, etc.

This very responsible appointment, lasting several years, requires a fully qualified Civil Engineer with an exceptional degree of experience professionally as well as in responsible administration of engineering contracts.

(B) RESIDENT ENGINEER.

Fully qualified Civil Engineer required to act as deputy to Chief Resident Engineer for constructional works as above. Wide experience required, with good knowledge of administration of contracts.

(C) QUANTITY SURVEYOR.

Required to be a corporate member of the Royal Institute of Chartered Surveyors and to be responsible to the Chief Resident Engineer for all measurement, payment and other contract questions on the constructional works as above.

Replies, with full details of qualifications and experience, which will be treated in the utmost confidence, should be addressed "T," LIVESEY AND HENDERSON, NATIONAL HOUSE, 12-18, MOORGATE, LONDON, E.C.2. L 117

GENERAL MANAGER required for important Marine Engineering Works in North-East England. Very good prospects for the right man.—Apply BOX L 150, Offices of ENGINEERING.

DRAUGHTSMAN required for Engine Design Schemes on small high-speed diesels must have initiative and experience. Good salary. Pleasant working conditions. Pension Scheme.—Apply CHIEF PERSONNEL OFFICER, PETTERS LIMITED, CAUSEWAY WORKS, STAINES. G 650

DETAIL DRAUGHTSMEN required. Men experienced in Industrial Furnace, Gas Plant or similar work preferred. Write giving full particulars and salary required to CHIEF DRAUGHTSMAN, FURNACE DEPARTMENT, THE WELLMAN SMITH OWEN ENGINEERING CORPORATION LIMITED, PARNELL HOUSE, WILTON ROAD, LONDON, S.W.1. L 125

SUPERINTENDENT ENGINEER

required for service in NIGERIA by old-established British concern to supervise and control an expanding group of factories processing a primary product, with the attendant European and African engineering staff.

Good all round practical mechanical engineering knowledge is essential with particular experience of medium range diesel engines and hydraulics. Experience of the erection of light structural steelwork and foundations an advantage.

Fully furnished and equipped housing. Contributory pension scheme providing for retirement from age 55. First class passages provided. Tours of 20 months, followed by 4 months leave on full pay.

SALARY by arrangement and will be substantial.

Age range preferred 40 to 45.

Applicants will be interviewed in U.K. at convenient times.

In first instance apply in full confidence to BOX L 171, Offices of ENGINEERING.

WORK STUDY.

MAN WITH UNIVERSITY DEGREE OR THE EQUIVALENT and some industrial experience wanted to organise work study. Specialised training in work study, particularly the methods side, will be given. The post is an interesting one and offers excellent opportunities for training and development of a new section. Contributory pension scheme.—Apply, stating age, experience and training, to PERSONNEL MANAGER, FERODO LIMITED, CHAPEL-EN-LE-FRITH, VIA. STOCKPORT. L 126

J. BROCKHOUSE & COMPANY LIMITED, WEST BROMWICH

Invite applications for the following positions in their Transmission Division which is being established at their West Bromwich Works:—

GRADUATE ENGINEER

with specialist knowledge of Hydraulics for research in the field of Hydraulic Transmissions.

SECTION LEADER

for Transmission Design. Comprehensive knowledge and experience of gears and gear boxes essential.

Salaries will be commensurate with qualifications and experience, and the appointments offer excellent prospects in a rapidly expanding field.

Good contributory pension scheme in operation.

The successful applicants will be required to work in Southp rt for a few months, during which period all reasonable expenses will be paid.

Apply in writing:—

PERSONNEL MANAGER,
BROCKHOUSE ENGINEERING LIMITED,
SOUTHPORT, LANCS. L 185

JOSEPH LUCAS (ELECTRICAL) LIMITED intend to appoint a **DEPUTY CHIEF METALLURGIST** with a view to his subsequent promotion to Chief Metallurgist in charge of a staff of about forty. The applicant should, preferably, have an honours degree in metallurgy and be between the ages of 35 and 45. Experience in the field of light engineering is essential, and in quantity production a distinct advantage. He will be responsible for, and with the aid of specialists be expected to deal with the specification and testing of, incoming materials; production heat treatment, which includes heating in controlled atmosphere furnaces and by induction, carburising by the solid, liquid and gaseous methods, and nitriding; with welding, brazing and soldering, and with pyrometric control. He must have a knowledge of most kinds of cold-forming and machining processes. He will be required to advise metallurgically those who are responsible for engineering design, and to collaborate with those who have to maintain an unusually high level of quantity production. Special notice will be taken of an ability to write clear reports.—Apply to the PERSONNEL MANAGER, JOSEPH LUCAS (ELECTRICAL) LTD., GREAT KING STREET, BIRMINGHAM, 19, quoting reference PM/D/128. K 986

ASSISTANT DEVELOPMENT ENGINEER required by important company within easy reach of Leicester. Higher National Certificate in Mechanical Engineering essential and applicants should have had Works and Drawing Office experience. Age 23-26. Applications marked Private and Confidential should be addressed in first instance to The Personnel Manager, BOX L 122, Offices of ENGINEERING.

DRAUGHTSMAN required for Engineering Dept. of Manufacturing concern. Age approx. 24-30. Educated to H.N.C. preferred. Experience in General Engineering, Plant Layout, Buildings, Factory Services, etc. Some electrical experience would be an advantage. Good man capable of working with minimum of supervision would find good conditions of employment, Canteen facilities, pension Scheme etc. Replies giving full details and salary required to MARTIN BLACK & CO. (WIRE ROPES) LTD., SPEEDWELL WORKS, COATBRIDGE. L 137

SENIOR DRAUGHTSMEN required by old-established firm of hydraulic engineers in Cheshire, preferably with design experience in hydraulic presses, valve gear and pumps. Good salary to suitable men. Five-day week, pension scheme and canteen facilities.—Apply in confidence stating age, experience and salary required to BOX L 156, Offices of ENGINEERING.

Part-time assistance required by Westminster Consultants for detailing of concrete bridges. Liberal remuneration for experienced

STRUCTURAL DRAUGHTSMAN. Write in confidence stating age and details of experience.—BOX L 158, Offices of ENGINEERING.

DRAUGHTSMAN required by Consulting Engineers, Westminster, for reinforced concrete bridge work. Salary up to £800 per annum according to ability. Interesting work and excellent prospects. This year's holiday arrangements honoured. Write stating age and details of experience.—BOX L 159, Offices of ENGINEERING.

BRITISH CELLOPHANE LIMITED, BRIDGWATER, SOMERSET,

seeks **SENIOR AND JUNIOR DRAUGHTSMEN,** for both PERMANENT and TEMPORARY appointments, for work on machine design and chemical plant layout. Applicants should possess at least O.N.C. and have had three years' shop experience. Five-day week, Pensions Fund scheme for permanent appointments. Ref. No. E.48.Eg.

The TEMPORARY appointments are for a period of approximately two years' duration, subject to three months' notice and include generous subsistence allowances, and periodic home return rail fares.

ESTIMATOR (PERMANENT).—Applicants should have served an engineering apprenticeship and have technical education up to O.N.C. standard. The work involved will be on the preparation of material and labour specifications in connection with engineering work, electrical estimating experience an advantage. Ref. No. E.49.Eg.

ASSISTANT ENGINEER, age 23/30 (permanent).—Applicants should have an honours degree in mechanical engineering and have had some practical works experience. The duties will be on development, improvement and maintenance of chemical and other plant. Ref. No. E.50.Eg.

ASSISTANT ENGINEER, age 25/50 (permanent).—Applicants should have a university degree and have works experience, or be an A.M.I.Mech.E. The duties will be on development, improvement and maintenance of plastic films extrusion plant and ancillary equipment. Ref. No. R.45.Eg.

Write to the PERSONNEL OFFICER, stating full particulars and salary required, and quote Ref. Nos. as indicated. L 32

C.A.V. LIMITED

require an

ASSISTANT DEVELOPMENT ENGINEER

on the design and development of special purpose testing equipment simulating vehicle operating conditions.

Applicants should be up to 30 years of age and must have Higher National Certificate with a sound knowledge of machines and mechanisms; a familiarity with electric or electronic equipment would be an advantage.

Salary according to qualifications and experience.

Five-day week, pensionable, good sports and social facilities.

Write stating age, qualifications and experience to:—

Personnel Manager,
C.A.V. LIMITED,
Warple Way,
Acton, W.3.
L 225

J. MOWLEM & CO., LTD. have vacancies in their Concrete Laboratory for a

CONCRETE ENGINEER and an **ASSISTANT CONCRETE ENGINEER.** These vacancies are permanent and form an excellent opportunity for the right type of man. Salary according to age and experience. For the junior position previous experience in this type of work is not essential as adequate training will be given.—Apply, giving all details in own handwriting to BOX L 20, Offices of ENGINEERING.

DRAUGHTSMAN, MECHANICAL, required for work on heavy mechanical engineering and pulverised fuel equipment. Experience this class of work would be useful. Voluntary superannuation scheme available working week five days. Please reply, quoting experience. Salary approx. £800.—BOX L 41, Offices of ENGINEERING.

DRAUGHTSMEN (SENIOR AND JUNIOR) required for work in connection with the following branches of Coke Oven and Gasworks plants.

(a) Mechanical and By-Product Plant.
(b) Pipework.
(c) Steelwork for Buildings and Conveyors.

Applicants should be competent men able to work with the minimum of supervision. Technical qualifications to O.N.C. or beyond. Good remuneration and prospects for capable men. Pension scheme. Five-day week; Canteen Facilities.—State age and experience to the PERSONNEL OFFICER (D.O.), WOODALL-DUCKHAM CONSTRUCTION COMPANY LTD., WOODALL-DUCKHAM HOUSE, 63-77, BROMPTON ROAD, LONDON, S.W.3. G 550

DESIGNERS AND DRAUGHTSMEN.

Expanding Drawing Office (Newcastle) requires Design Draughtsmen for Jig and Tool Work, and for the design of special purpose Boring and Milling Machines.

Salaries in accordance with educational standard and experience. Permanent positions in long-established concern for suitable applicants. Pension and Welfare facilities available.

Please give age, education, experience, etc.—Write L 200, Offices of ENGINEERING.

DRAUGHTSMEN/DESIGNERS. Required by London Office of SHELL PETROLEUM COMPANY LIMITED. Fully experienced in one of the following categories:—(1) Structural steelwork, with some experience of R.C. structures and foundation work preferred. (2) Mechanical or general engineering. Preferably between the ages of 30 and 40. Salary according to age and experience. Pension Scheme. Canteen facilities. Social and Sports Club facilities. Please apply in writing, giving full details to STAFF DEPARTMENT (R), ST. HELEN'S COURT, GREAT ST. HELEN'S LONDON, E.C.3. L 115

DRAUGHTSMEN AND STRESSMEN required for Railway Rolling Stock; knowledge of the industry preferable but not essential; applicants with knowledge of shipbuilding, aircraft, bus or light structural work would be considered.—Apply CHIEF ENGINEER, METROPOLITAN-CAMMELL CARRIAGE & WAGON COMPANY, LIMITED, SALTLEY, BIRMINGHAM. L 104

SENIOR DRAUGHTSMAN required, London area. Heavy Mechanical Engineering experience essential, knowledge of gearing an advantage.—Write stating age and salary required and giving full details of experience to The SECRETARY, THE POWER PLANT COMPANY LIMITED, WEST DRAYTON, MIDDLESEX. L 89

Classified Advertisements continued on Page 114

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Taylor Jumbo is the mobile crane of infinite use—based on a powerful and reliable system of hydraulics. **Grabbing,** craning, elevating, stacking, pole positioning—it's all in the day's work for Jumbo.

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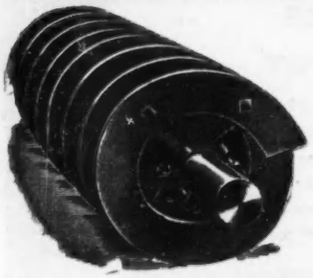

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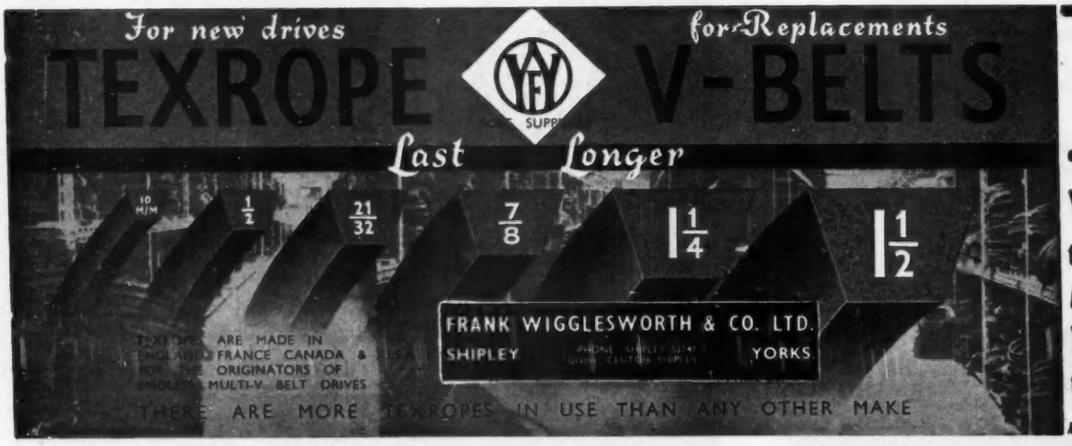

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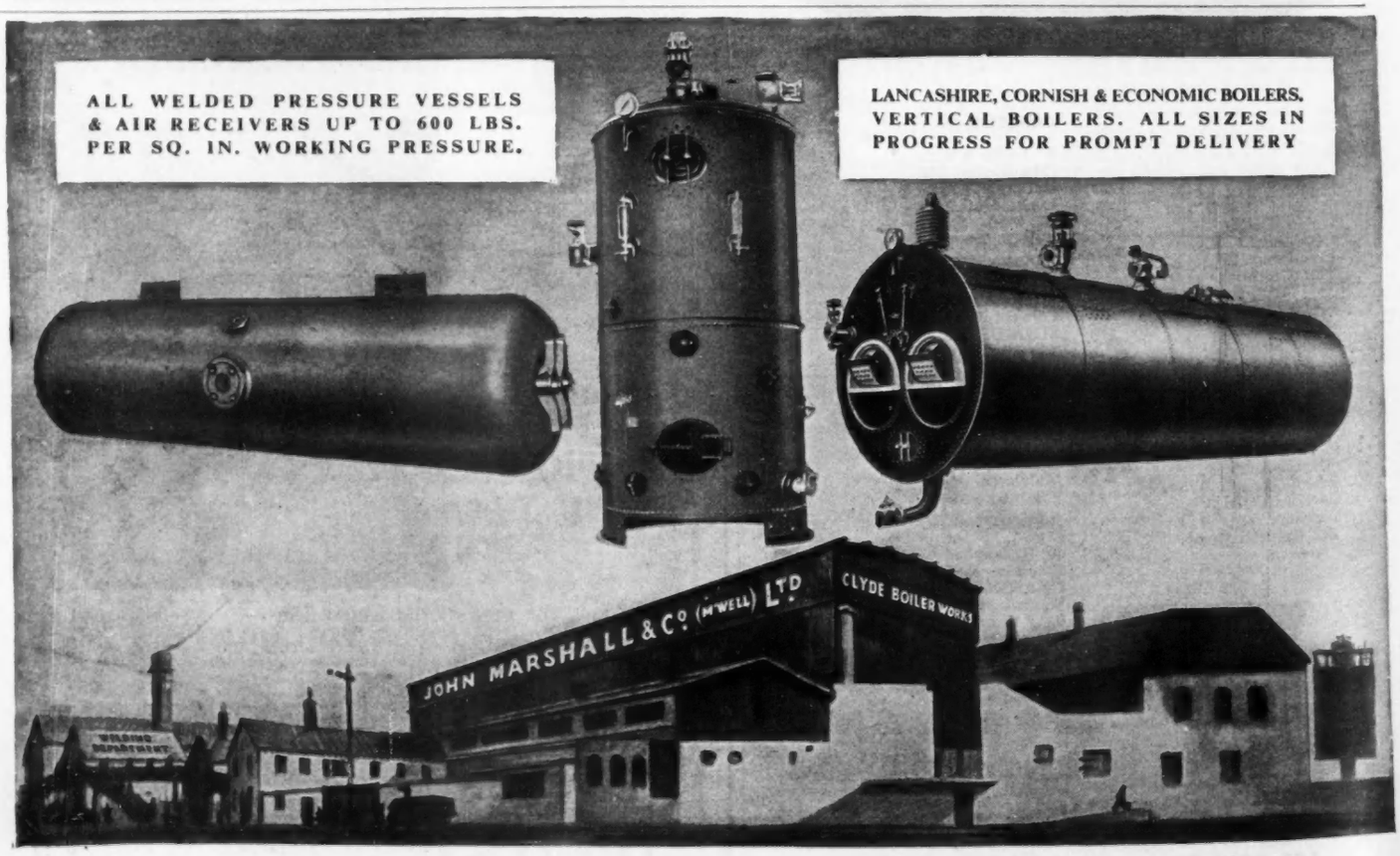
the originators and largest makers of V-belt drives in this country.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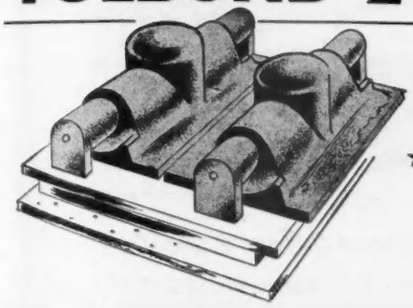

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1% Fulbond 2 replaces 10% natural sand

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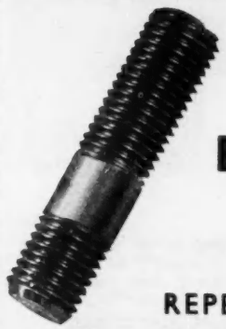

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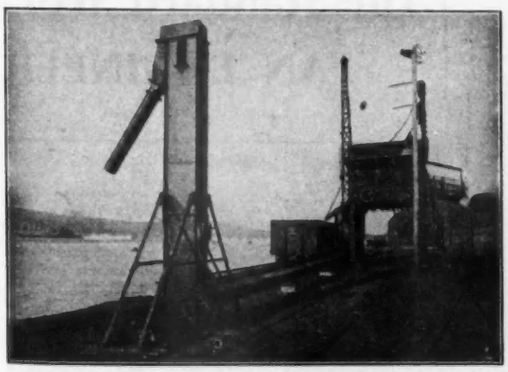

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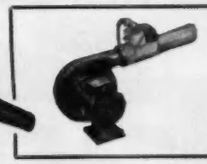
(Hot or cold!)

The problem of supplying high velocity air for suction or blowing can be easily resolved by the use of "Secomak" Electric Blowers. Two versatile and adaptable types are available. "Statair" units for fixed installations, and portable units for such applications as clearing dust and damp from otherwise inaccessible machinery. Several models are available of each type. All can be used economically and efficiently for either suction or blowing and can easily be adapted to blowing hot air.

See Data Sheets 101, 104, 132G.



The "Secomak" Heater attachment permits any "Secomak" Electric Blower to be used for blowing hot air at temperatures up to 700° F.

See Data Sheet 130 G

Secomak REGD **Electric BLOWERS**

FOR HIGH VELOCITY SUCTION & BLOWING

And make a clean sweep . . .

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Speed, quietness and ease of handling are features of the "Secomak" range of Vacuum Cleaners. They are compact yet capacious. They will rid your premises of dust, dirt and swarf cheaply and quickly.

Write for Data Sheet 511G for full details of the "Secomak" Range of Industrial Vacuum Cleaners.

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AP210-155

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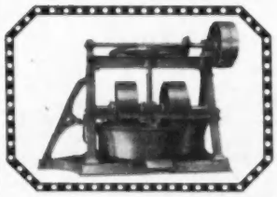
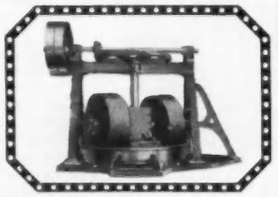


TRADE Smedley MARK



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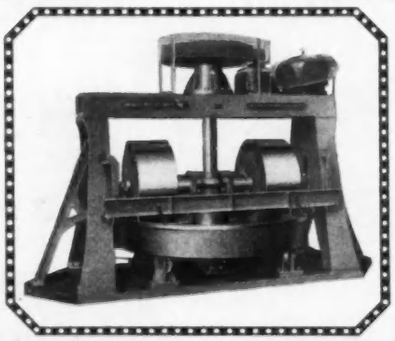

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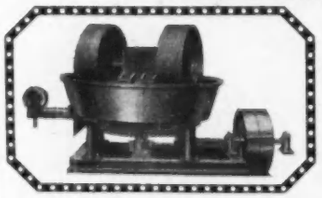

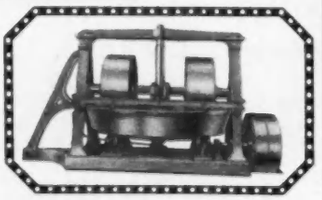

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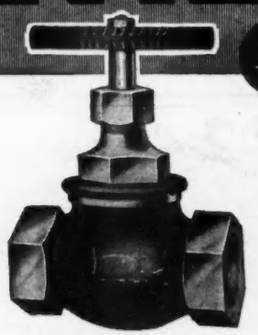

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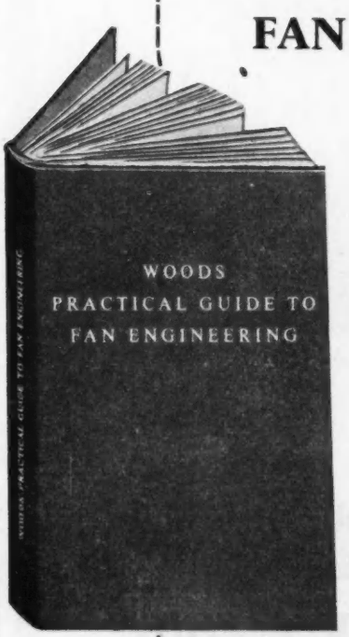

"Woods Practical Guide to Fan Engineering" by W. C. Osborne, B.Sc., and C. G. Turner, D.A.A. 143 diagrams, 33 charts, 61 tables. 227 pages, bound in full cloth, 9" x 6". Price 12/6.

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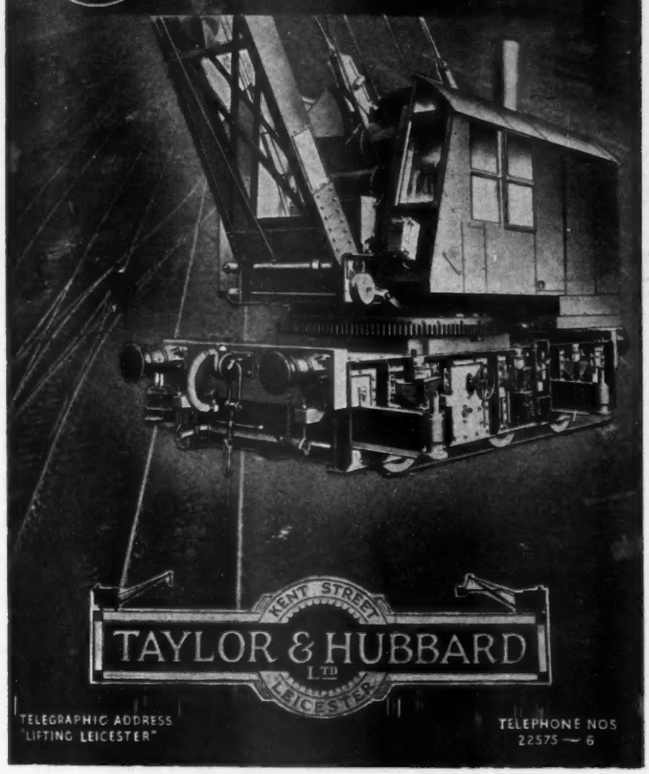

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2000 hammer blows a minute from your electric drill!

Brief Specification
The best operating speed is between 1500-2000 r.p.m. and the Electric Drill should have a minimum ½in. chuck. Capacity: Rawlplug Hammer Drills No. 3H (⅜in. *diameter) to No.* 20H (⅝in. *diameter). Weight* 2¼ *lb.*

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Turn an ordinary electric drill into a sturdy hard-working power hammer, simply by slipping a Rawlplug Drill-Hammer into the chuck! This ingenious device converts rotary motion into percussion—one blow per rev. of the drill; with it you can bore concrete, etc. (up to ¾ in. holes) at really surprising speeds. Weight of blows adjustable to 'light', 'medium' or 'heavy'. The Rawlplug Drill-Hammer is light and easy to use, yet has ample strength for long service and the severe treatment of practical conditions. An automatic clutch ensures that percussion takes place only when the tool is pressed against the masonry. *This tool will save a lot of time and money—write now for illustrated folder containing full technical details.* 9474

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Specialists in the production of the finest quality Sand Castings, Gravity Die Castings and Pressure Die Castings in all Light Alloys and Non-Ferrous Metals by the most modern methods.

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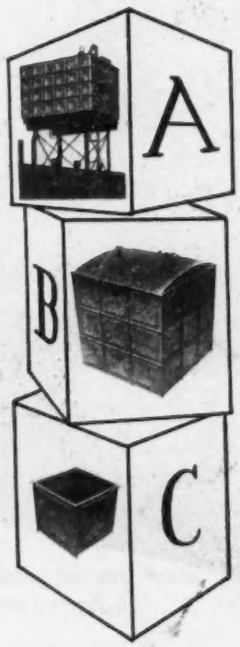
Simple as . . .

. . . building A, B, C bricks is the erection of a MECHANS Pressed Steel Tank



- The tanks are composed of only three unit plates, types A, B and C.
- Capacity may be increased by extending floor area or depth.
- Joints are made oil or water-tight by the insertion of special plastic composition.
- Plates are bolted together and no riveting is required.
- The tanks are suitable for erection on concrete or masonry foundations or can be supplied with steel towers.

MECHANS LIMITED SCOTSTOUN IRON WORKS, GLASGOW, W.4

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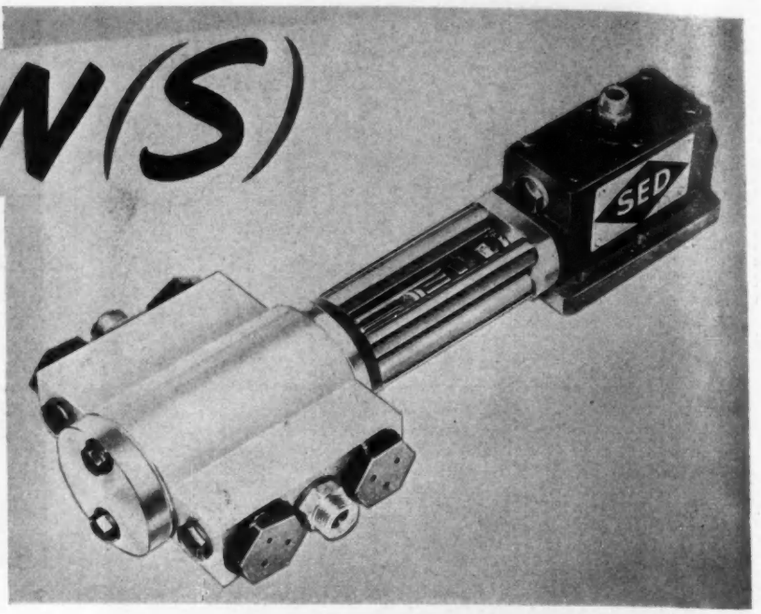

The S.E.D
'NEUMO' Mk. III
PNEUMATICALLY OPERATED PUMP UNIT

THE MOTOR

- ★ Two moving parts only.
- ★ Hardened and ground piston and valve.
- ★ Cast iron body with honed bore.
- ★ Non-stalling.
- ★ Negligible air consumption.
- ★ High power output.

THE PUMP

- ★ Double acting.
- ★ High efficiency.
- ★ Self-contained valves.
- ★ Easily serviced.
- ★ Pumps liquids up to 200 deg. F.

SIMPLICITY MEANS RELIABILITY

TYPICAL PERFORMANCE FIGURES		
Air Pressure	60 lbs. P.S.I.	60 lbs. P.S.I.
Consumption	2½ Cu. F.P.M.	2½ Cu. F.P.M.
Delivery	45 gals. P.H.	120 gals. P.H.
Del. Pressure	30 lbs. P.S.I.	5 lbs. P.S.I.

WIDE RANGE

Owing to the design and materials employed in its construction, the "Neumo" Mk. III Pump Unit is capable of handling a very wide range of materials such as paint at 200 deg. F., petrol, oils, from paraffin to high viscosities, Solvex, Mangersol, Basol, Trichlorethylene and all types of cellulose solvents, etc.

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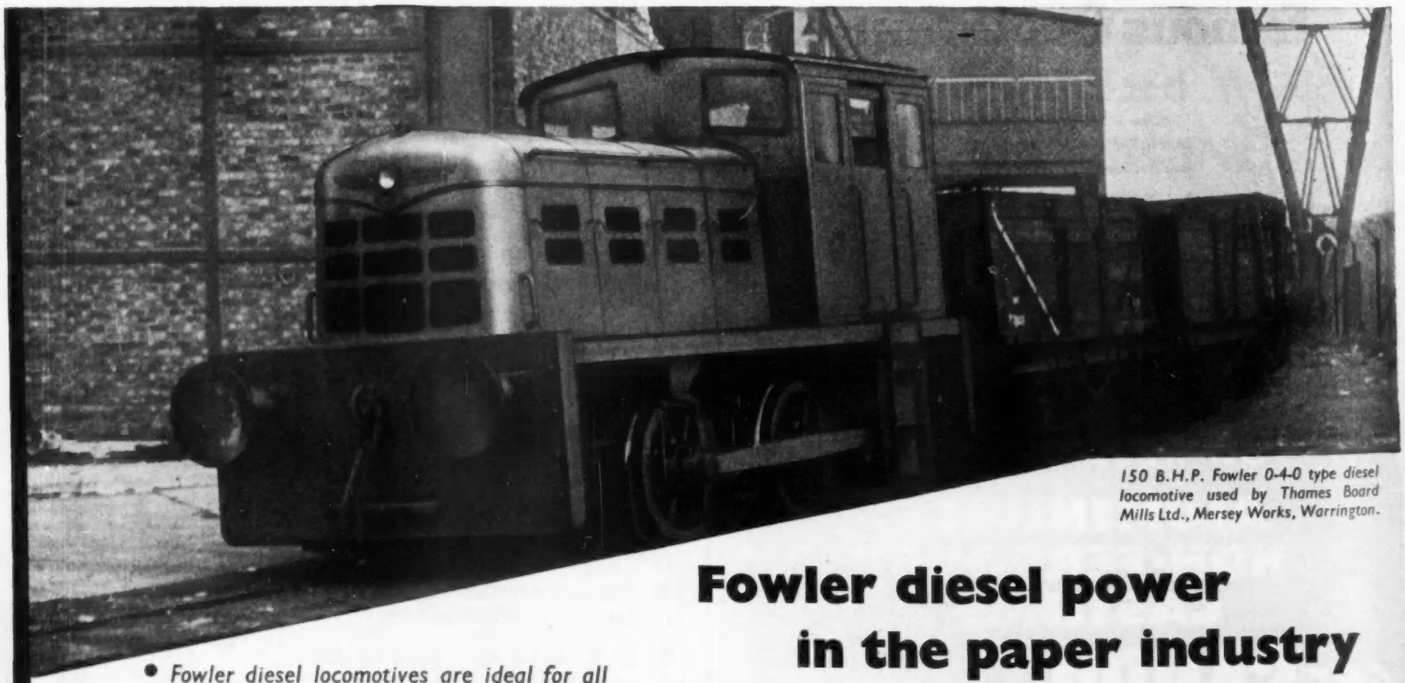

150 B.H.P. Fowler 0-4-0 type diesel locomotive used by Thames Board Mills Ltd., Mersey Works, Warrington.

Fowler diesel power in the paper industry

- *Fowler diesel locomotives are ideal for all industrial purposes, general or specialised.*
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Products of the Marshall Organisation, Gainsborough, England.

Experience inspires this work

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always consult

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first, for sidings

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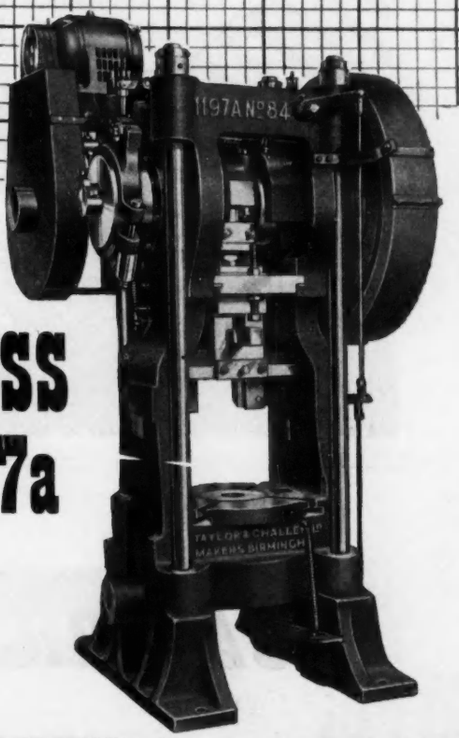
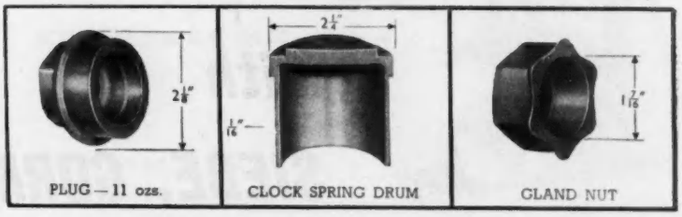
Telephone: Darlington 5226, London, 5a Deans Yard S.W.1. Telephone Abbey 1365/6

PRESSES FOR HOT FORGING TO CLOSE LIMITS



PRESS 1197a



These presses have the rigidity, speed and accuracy essential for hot forging, with a uniform finish, brass and other non-ferrous alloys. Press 1197A gives a pressure of 100 tons, and the examples illustrated are typical brass forgings which it makes in closed dies. We make similar presses for this work up to 500 tons capacity.

TAYLOR & CHALLEN LTD.

BIRMINGHAM 19

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ROYAL DUTCH AIRLINES

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Central America.....7 flights weekly
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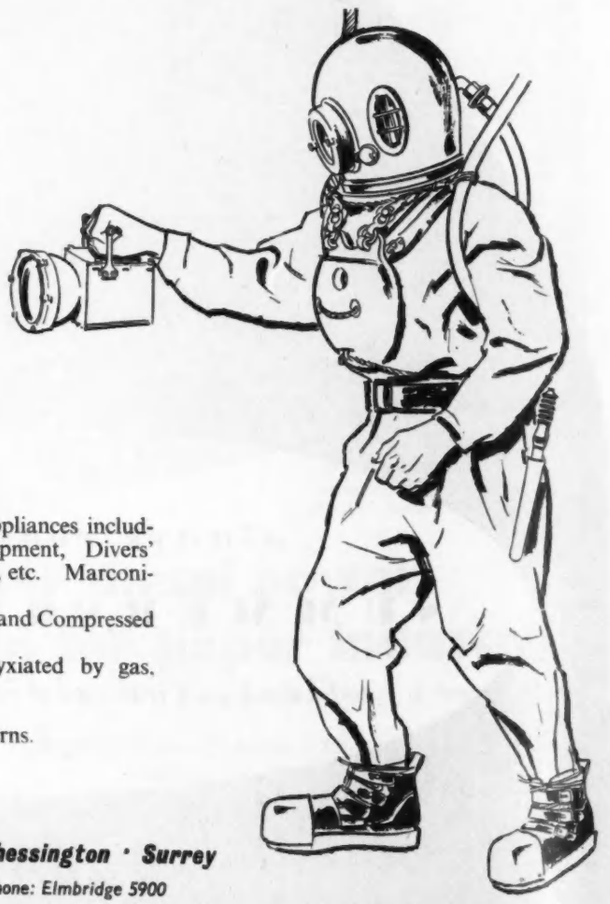
with

SIEBE, GORMAN



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RESUSCITATION APPARATUS for persons asphyxiated by gas, shock or drowning.
PROTECTIVE CLOTHING Goggles, Gloves, etc.
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For diesel power units in the 60 to 600 b.h.p. range . . .

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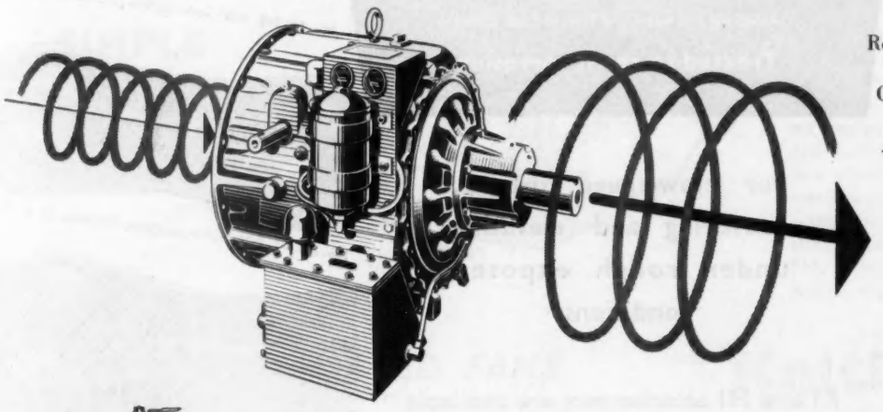
TORQUE CONVERTERS



Rolls-Royce will shortly be in production with a range of three-stage Torque Converters, made under licence to the Twin Disc Clutch Company of America, for Rolls-Royce oil engines. This range of converters covers engines of 60 to 600 b.h.p.

Applications Include :—

HOISTS
TRACTORS
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SIR GEORGE GODFREY & PARTNERS (1938) LTD.

OIL-FREE AIR IN INDUSTRY

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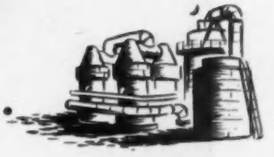
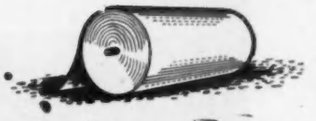
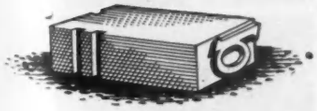


CHEMICAL . . . .

. . . . . CEMENT

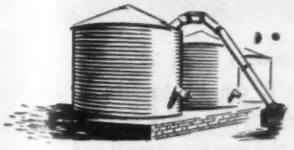


PAPER . . . . . .

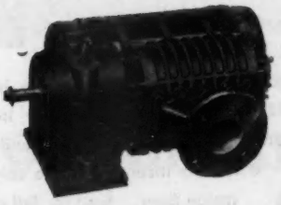


. . . PRINTING

SEWAGE . . . . .



. . GRAIN



Godfrey positive displacement blowers are employed in a variety of industrial processes where a supply of oil-free air is required. Single units handle air flows up to 3500 cfm. at pressures up to 10 psi. Write for further particulars.
Also available: VACUUM PUMPS, GAS BOOSTERS, SUPERCHARGERS, DIAPHRAGM PUMPS.

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THE COVENTRY
MARK 5
STEEL ROLLER CHAINS & WHEELS

(Replacing Malleable and Pressed Steel Chains)

Treated to resist corrosion

No. 180 408. 1·15" pitch, replacing Malleable 32

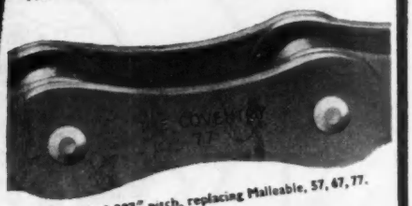
No. 180 519. 1·375" pitch, replacing Malleable, 42, 50

No. 180 538. 1·50" pitch, replacing Malleable, 52

No. 180 570. 1·63" pitch, replacing Malleable, 55

No. 180 581. 1·63" pitch, replacing Malleable, 45

No. 180 558. 1·65" pitch, replacing Malleable, 62, 72½



No. 180 671. 2·297" pitch, replacing Malleable, 57, 67, 77.

No. 180 708. 2·609" pitch, replacing Malleable, 75, 78, 88.

For slow-speed driving, conveying and elevating under rough exposed conditions.

KI and MI attachments are available

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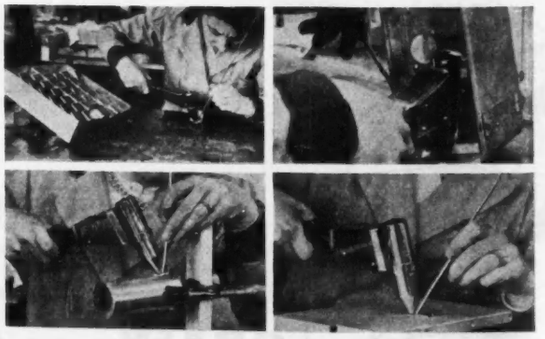
This is the BELARK
ALUMINIUM SOLDERING TOOL



Here is a tool which solders aluminium and its alloys as easily as any other materials. No oxidization takes place between the operations of cleaning and tinning, the Belark Soldering Tool carrying out these two operations simultaneously. Cleaning of surfaces is achieved by a vibrating steel-wire brush located in the centre of the solder bit. Designed for use in mass-production operations, it can be handled by unskilled persons. No flux and no additional heat is necessary. The tool is supplied with two interchangeable solder-bits, one for flat surfaces and one for corners and inside faces. *Send for full details.*

An essential tool where fine soldering of Aluminium is required

BK 4006

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Telephone, GERrard 2178

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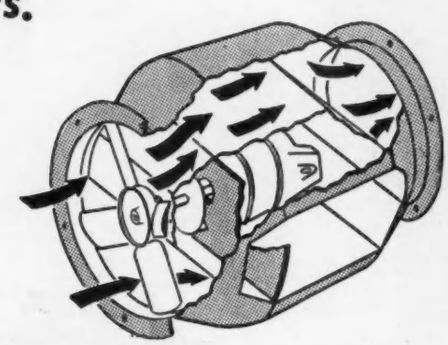
SOME FANS GET RID OF CORROSIVE FUMES

(but corrosive fumes get rid of some fans!)
The choice is yours.

SIMPLE
SAFE
CERTAIN



But before choosing consider the "Tornado" BIFURCATED FAN range. Here, at last, is a fan which is more than a match for the most stringent demands. Corrosive, inflammable, or excessively hot fumes or gases are treated with contempt.
And have you noticed the design?—see how the fumes flow through the substantial steel casing—see how the motor is sealed-off from the fumes yet open to atmosphere—see how the whole compact unit is built for easy installation, even in existing pipe lines.
This is, in fact, the fan for you.
Publication No. 28/2 awaits your request.

"Tornado" *BIFURCATED FANS*
(with sealed-off motors)

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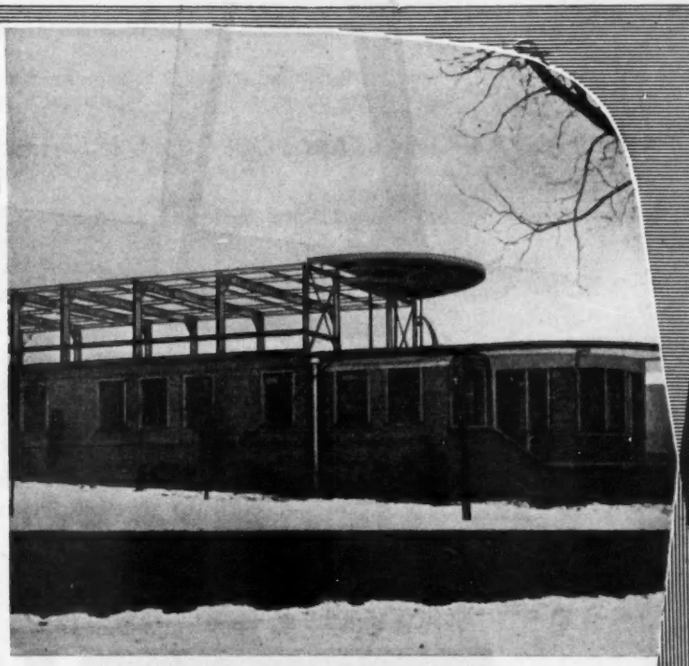
T.A. 5843/556

Aluminium Alloy

IN WELDED STRUCTURES

This new all-welded aluminium portal frame structure was erected for Ferodo Limited at Chapel-en-le-Frith. It is a second storey to an existing building, which had not been designed to take such an extension. It was therefore essential for dead loads to be kept to a minimum, and aluminium was the obvious choice.
The advance in welding technique of aluminium alloys extends widely the opportunities for using aluminium in this type of structure, where clean lines, increased headroom and economy of metal are required.



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THORNABY-ON-TEES

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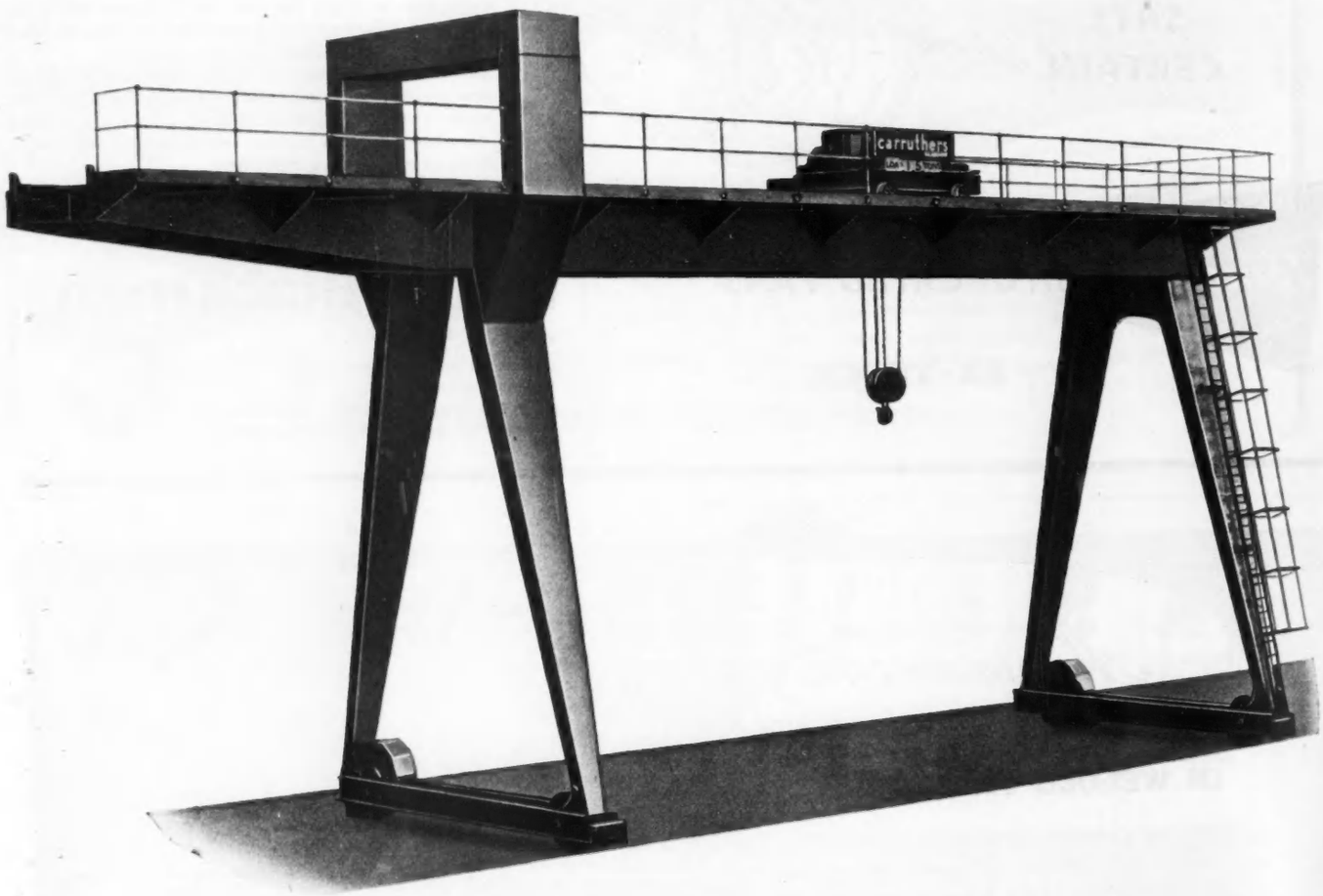
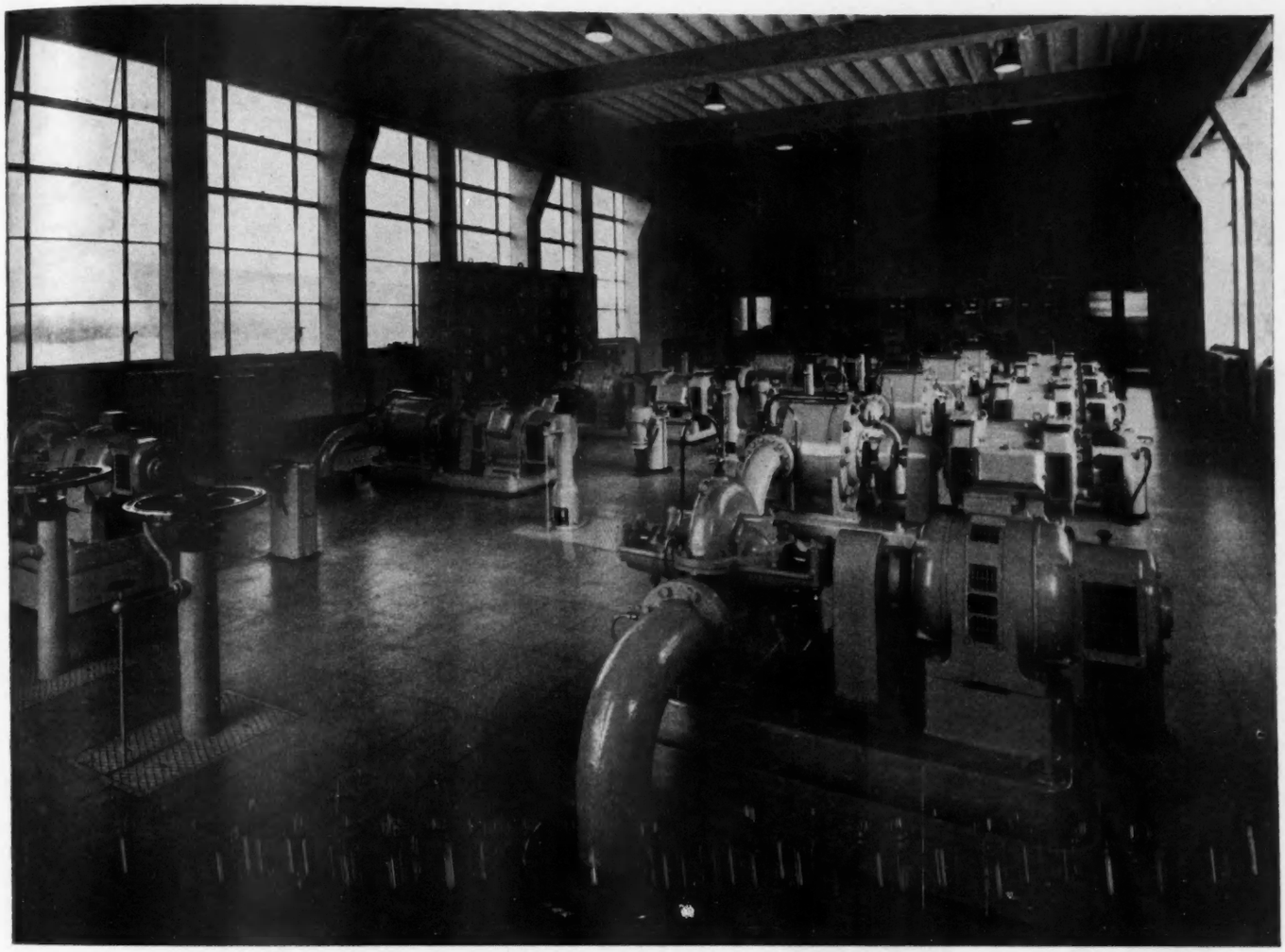
GOLIATH
OVERHEAD TRAVELLING GANTRY
CRANES



A typical medium capacity "Goliath Crane" supplied recently to an electricity authority.

carruthers

J. H. CARRUTHERS & COMPANY LTD., GLASGOW, S.2
LONDON OFFICE: ABFORD HOUSE, WILTON ROAD, VICTORIA, S.W.1



Stowey Pumping Station in which are installed 9 SULZER Centrifugal Pumps absorbing 599 B.H.P., having a capacity of 10·4 million gallons per day.

In connection with the CHEW VALLEY scheme of the BRISTOL WATERWORKS COMPANY
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a total of 24 SULZER PUMPING UNITS have been supplied including plant for the following

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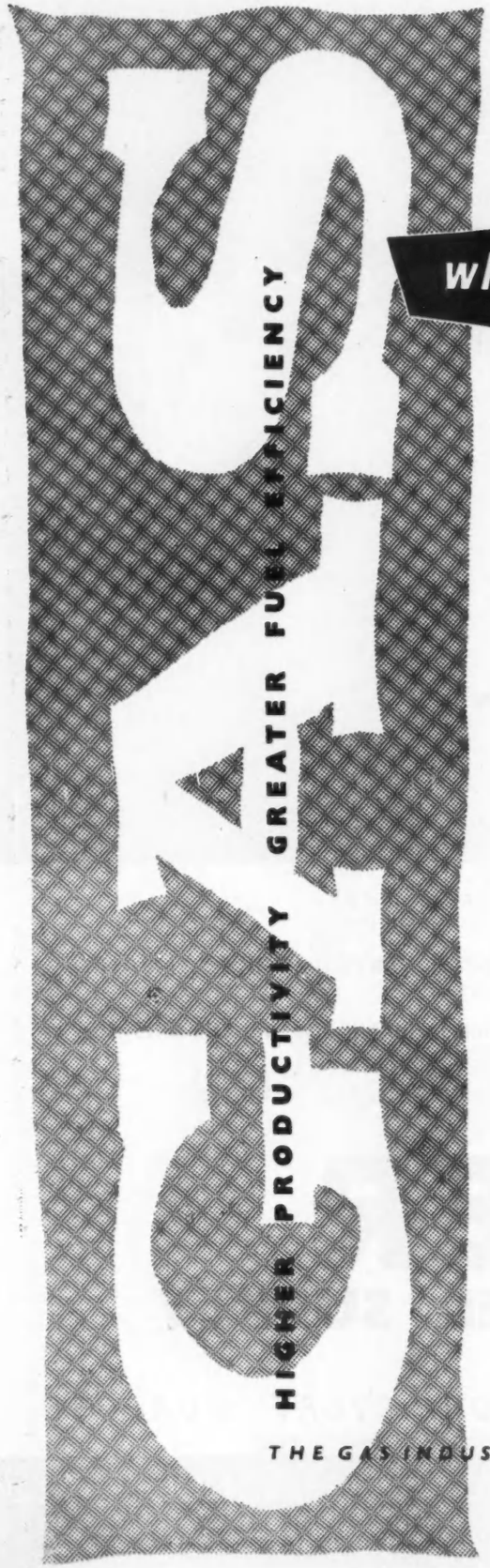


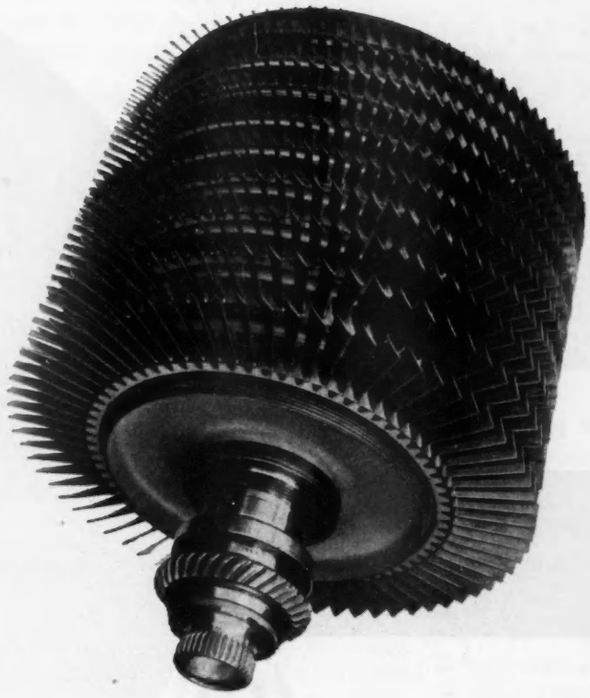
whatever your business

at each Area Gas Board you will find engineers with a surprising knowledge of it. Through a National Committee they pool their experience with their colleagues up and down the country. They have access to International information on gas for all purposes through a comprehensive Information Bureau in London.
Behind them highly qualified research and development teams maintained by the Gas Industry constantly increase fundamental knowledge on the smokeless and efficient usage of gas.
So it is that these Industrial Gas Engineers at the Area Gas Boards do not walk alone!—
You can benefit from this exceptional technical service organisation of which they are a part.

consult your area gas board

THE GAS INDUSTRY MAKES THE BEST USE OF THE NATION'S COAL

The Gas Council, 1 Grosvenor Place, London, S.W.1



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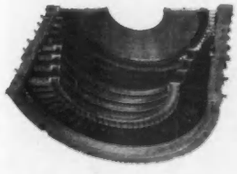
CLEAN AND BRIGHT—The hardening, tempering and annealing of metals demands close scientific control of the fuel and furnace. That is why gas, of constant calorific value, is ideal. It gives the 'right' furnace atmosphere. Ferrous metals emerge clean! Non-ferrous metals remain bright! Cleaning and polishing costs are reduced. Output is increased. The Industrial Gas Engineer at your Area Gas Board has been closely associated with recent research into furnace atmospheres to give these desirable results.

WHATEVER YOUR BUSINESS—**The Gas Industry appreciates the needs of individual consumers for prompt service and for advice which accords with the customer's special circumstances and requirements. Each Area Gas Board offers efficient service to users of gas-fired equipment and can give expert advice based upon the pooled knowledge of all the Boards and of gas users in other countries**

—CONSULT YOUR AREA GAS BOARD



ISSUED BY THE GAS COUNCIL

THE GAS INDUSTRY MAKES THE BEST USE OF THE NATION'S COAL

Where does it go?

Whatever you make in your works, you make dust.

Where does it go? Into the air your workers breathe, into the bearings of your machines? Think of the cost — and how much cheaper it is to control your dust. That's where we come in. Dust control is our job — our only job. We've had 30 years' experience putting dust in the only place it should ever go — the dustbin. We believe we could do the same for yours.

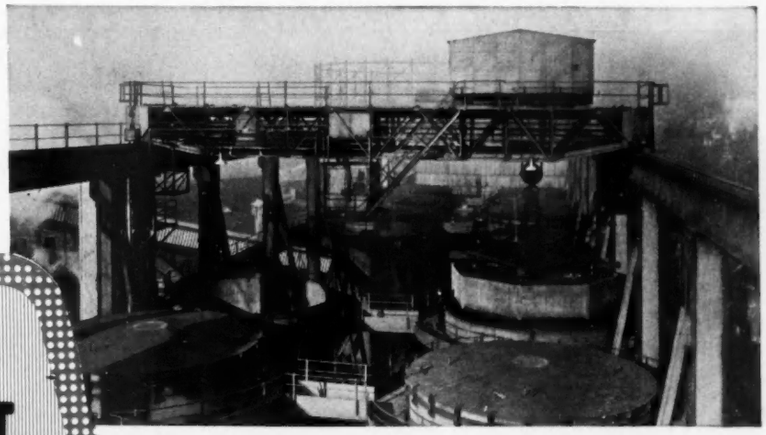
see us for dust

DALLOW LAMBERT

DUST CONTROL EQUIPMENT FOR INDUSTRY

DALLOW LAMBERT AND COMPANY LIMITED, THURMASTON, LEICESTER

CRC 50



60-ton Babcock overhead travelling crane serving tower purifiers at Neepsend Gas Works; East Midlands Gas Board.

Main Contractors: Newton Chambers & Co. Ltd.

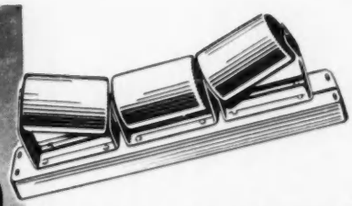
Babcock

Mechanical Handling Equipment

With over 50 years' experience in the design, manufacture and installation of all kinds of cranes and a wide variety of equipment to handle huge quantities of coal, ash, dust and other material for power stations and industrial plants, Babcock & Wilcox Ltd., are outstandingly well equipped to solve both the routine and the unusual problems of mechanical handling, on any scale.

If you want to unload, crush, screen and bunker coal at 1,000 tons an hour, to tipple a railway wagon in 30 seconds, to pump water-borne ash for a couple of miles, or to handle difficult " wet " materials such as slurry . . . and require plant that will keep on doing it all round the clock, economically and with a minimum of maintenance, Babcock & Wilcox Ltd. can almost certainly provide the scheme, and the plant you need.

Boiler house of the H. J. Heinz Co. (Pty.) Ltd. factory, Victoria, Australia, showing the Babcock coal conveyor and " Hydrovac " dust handling Cyclone serving the Babcock boiler plant



Babcock self-lubricating conveyor idlers.

MECHANICAL HANDLING EXHIBITION

Earls Court

May 9-19th

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1st Floor.

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ABCOCK & WILCOX LTD., BABCOCK HOUSE FARRINGDON STREET, LONDON, E.C.4.

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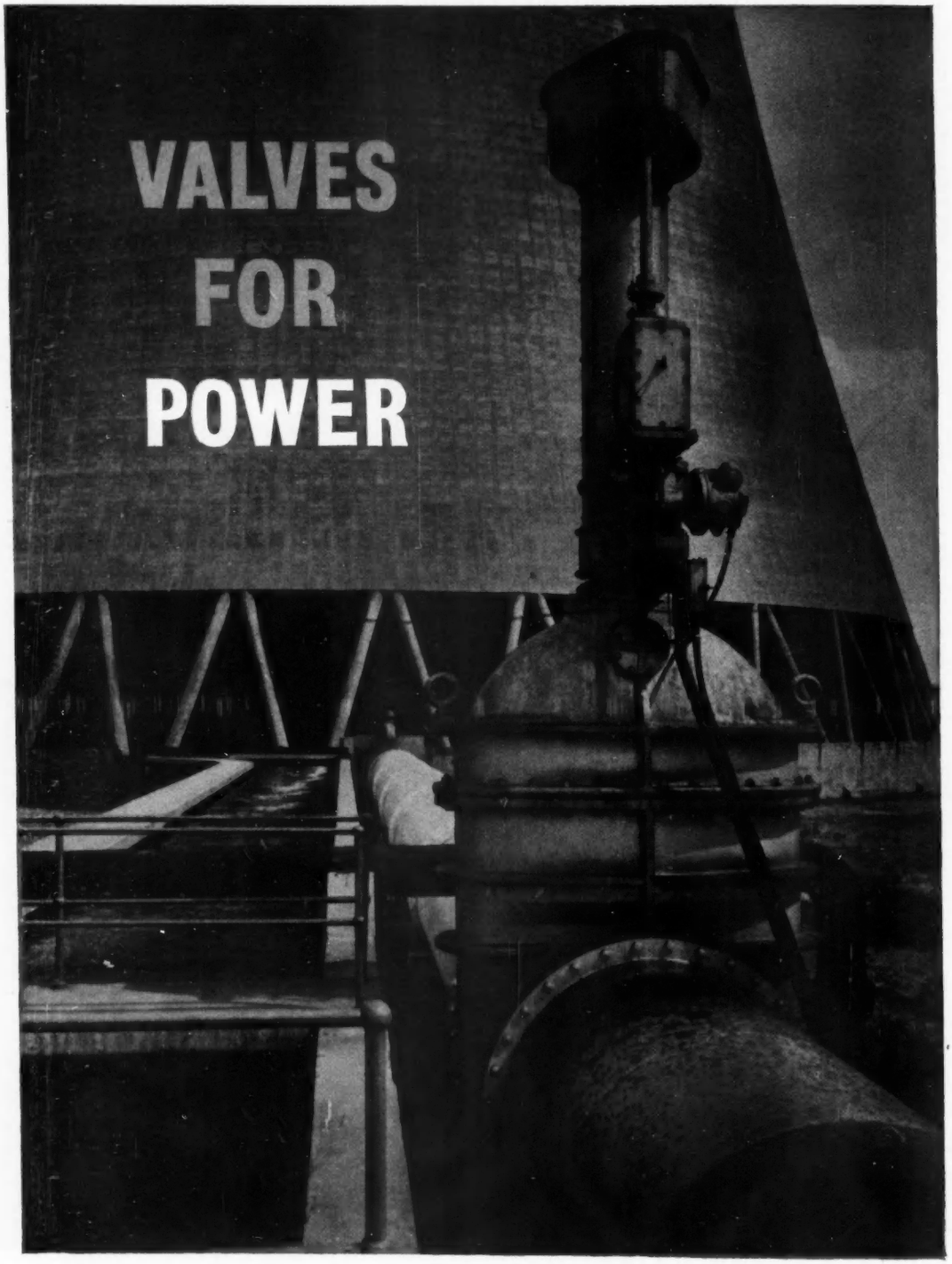

BLAKEBOROUGH POWER OPERATED VALVES FOR C.E.A. STATIONS SINCE 1948

Acton Lane 'B'	34
Agecroft 'B'	10
Bankside 'B'	10
Barking 'C'	47
Battersea 'B'	6
Belvedere	16
Blackburn	12
Blyth	30
Bold 'B'	5
Braehead *	16
Brighton 'B'	4
Brunswick Wharf	29
Carmarthen Bay	33
Carrington	27
Castle Donington	42
Chadderton 'B'	3[illegible]
Cliff Quay	6
Connahs Quay	9
Deptford East	11
Drakelow	58
Fulham	10
Fleetwood	3
Goldington	52
Huncoat	16
Hams Hall 'C'	22
Ince	16
Littlebrook 'C'	24
Marchwood	20
Northampton	4
North Tees 'C'	26
Poole	30
Plymouth 'B'	6
Portishead 'B'	34
Portsmouth	16
Rogerstone	9
Roosecote	8
Rotherham	4
Rye House	28
Skelton Grange	30
Staythorpe	16
Stella North	48
Stella South	36
South Denes	4
Tilbury	31
Thornhill	34
Wakefield 'B'	18
Walsall	8
Westwood	8
Willington	37
Woolwich	10

* Now under South of Scotland Electricity Board.

The adjoining list shows the allocation of over 1000 Blakeborough power operated circulating water valves, supplied or ordered for generating stations of the Central Electricity Authority over the past few years. The majority of these valves are above 20 in. bore, and nearly half are in the 40 in. to 90 in. size range. This is one section only of the vast amount of valve work with which we have been entrusted for the C.E.A. programme to date, covering a wide variety of types for circulating water and feed systems, condenser services, and other auxiliaries. The many thousands of valves involved, in connection with upwards of 70 stations, represent the largest single contribution in this class of equipment for the low pressure side.

BLAKEBOROUGH

J. BLAKEBOROUGH & SONS LTD · BRIGHOUSE · ENGLAND

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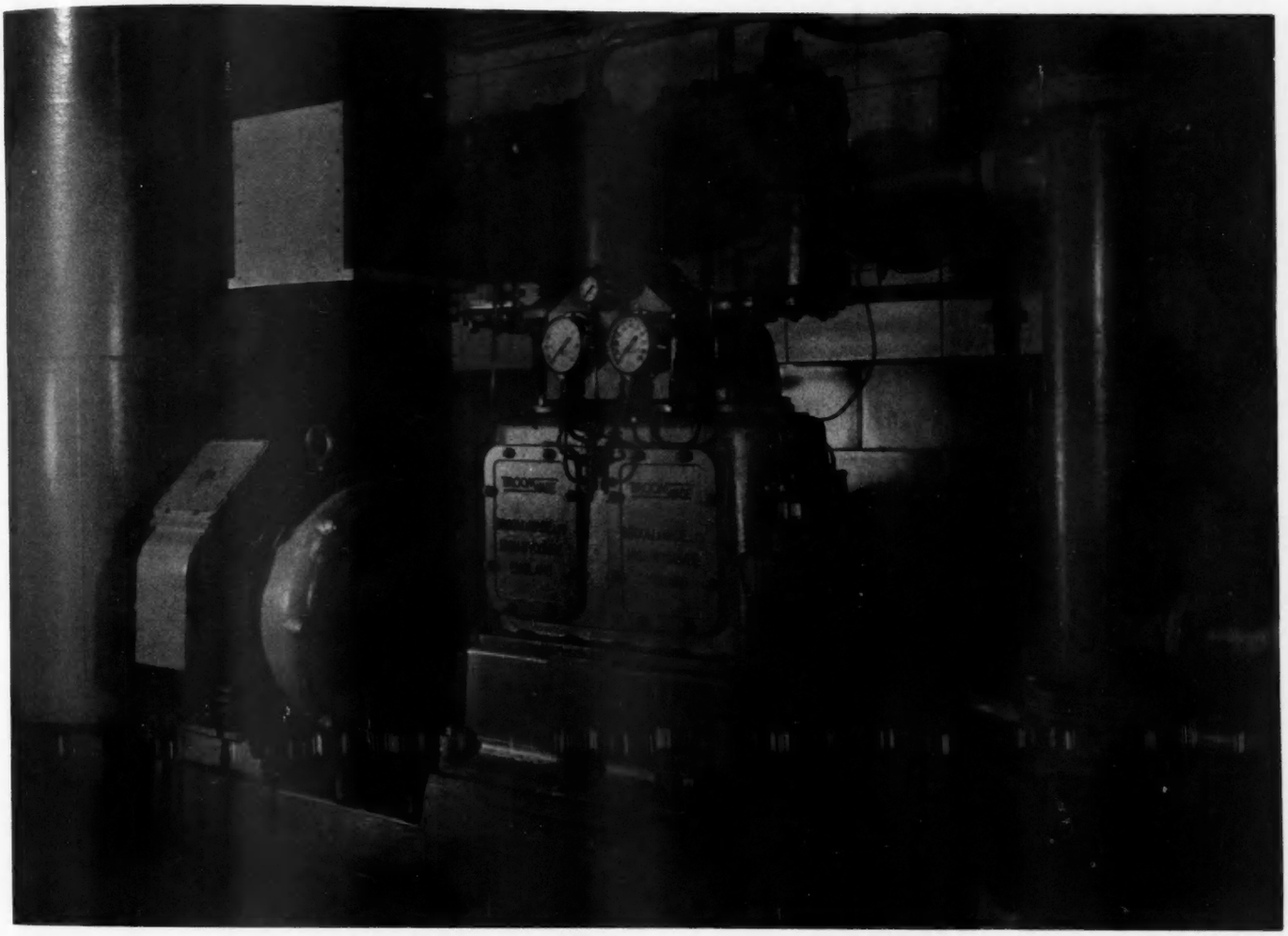


Photograph by courtesy of Central Electricity Authority (Eastern Division

"BROOMWADE" . . . IN THE POWER STATION

This " BROOMWADE " TS1A stationary-type air compressor helps maintenance requirements at the Rye House Generating Station, near Hoddesdon, by supplying compressed air for the operation of pneumatic equipment.

All over Britain " BROOMWADE " is playing a vital part in the construction, operation and maintenance of many modern power stations to meet industry's ever-increasing demand for electricity supply.

The " BROOMWADE " organisation, backed by more than fifty years' engineering experience of the highest order, is equipped to offer sound technical advice on any problem involving the use of compressed air.

A first-class after sales service is available throughout the world.

"BROOMWADE"

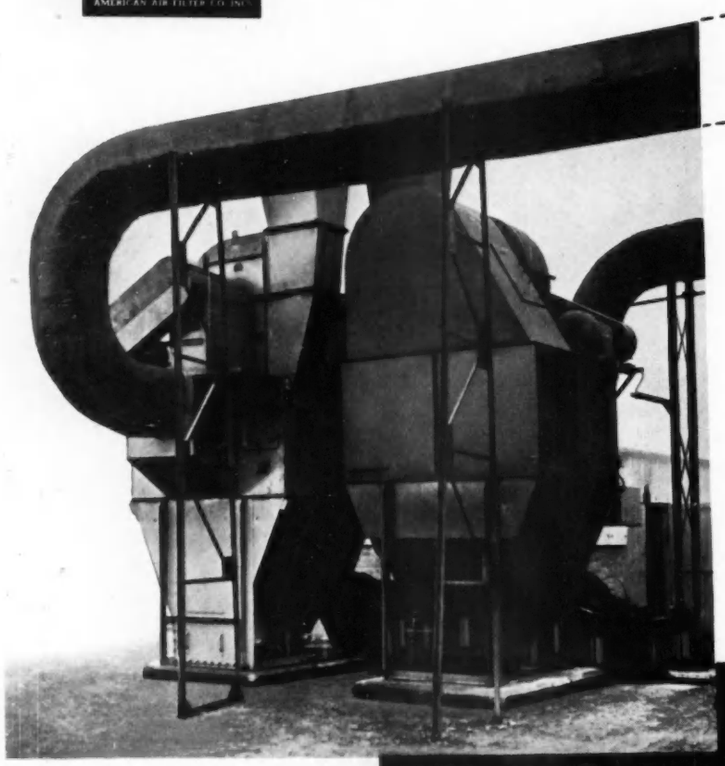
Aids industry

BROOM & WADE LTD., P.O. BOX No. 7, HIGH WYCOMBE, ENGLAND. Telephone: High Wycombe 1630 (10 lines) Telegrams: "Broom," High Wycombe

302 SAS

AIR CONTROL IN INDUST Y

AAF
AMERICAN AIR FILTER CO. INC.



LLOYDS (BURTON) LIMITED

one of the best-known names in iron and steel, is yet another firm that is tackling its dust control problems with the help of Air Control Installations Ltd.

Up to now five Rotoclones have been installed with a total capacity of 65,000 c.f.m., cleaning up sand-handling, shakeouts and fettling.

We specialise in the manufacture of equipment for every form of air treatment and in harnessing air to work for industry.

Consult our nearest branch.

ACI

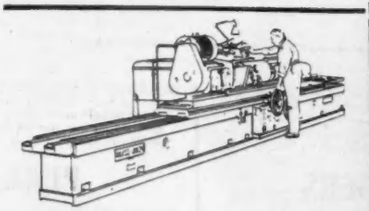
AIR CONTROL INSTALLATIONS LTD.

RUISLIP · MIDDLESEX · RUISLIP 4066

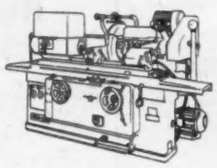
LONDON Welbeck 1308 & 1307 | BIRMINGHAM Midland 1165 & 1367 | MANCHESTER Central 0679 & 0670 | NEWCASTLE Whitley Bay 23046 | GLASGOW Co[illegible] 2923

ROTOCLONE – The plant that makes your works "NOT SO DU TY"

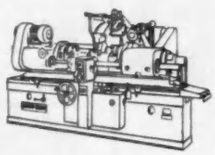
20 years double-shift duty and still working ✳



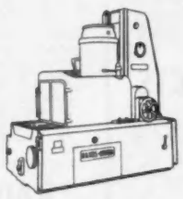
Roll Grinding Machines 12 inches to 72 inches diameter.



Plain, production, and universal Grinding Machines.



Multi-wheel crankshaft, pin and journal, Plunge Grinding Machines.



Surface Grinding Machines. (Circular table).

Also
Surface Grinding Machines. (Reciprocating table).
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That is the record of this Naxos-Union Roll Grinder installed in the strip and sheet mill of one of Britain's largest producers, the equivalent of forty years continuous use, with only one interruption for a major part replacement.
Its standards of accuracy and finish are still unsurpassed by even its most modern counterpart; while for speed of operation and convenience it has no equal.
Although the operating company has a world-wide reputation for the quality of its products, and operates a ruthless re-equipment policy, this machine still remains as evidence of the inherent quality and fitness for purpose of Naxos-Union Roll Grinding Machines.

✳ ***THE SECRET***

Unique spindle construction ensuring that the wheel spindle runs on its theoretical centre regardless of side loading, is one of the main reasons explaining Naxos-Union accuracy. Add to this, precision micro-feed to the wheel head, and split-tenths accuracy follows. Mirror-finish too, of course, to 0.5 micro inches if you want it.

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BRADFORD 8in. by 54in., motor drive, Norton type gearbox. Whitworth leadscrew, taper turning attachment, swing over bed 16¼in., swing over cross slide 9¾in., spindle bore 1⅜in., 12 spindle speeds, 16-400 r.p.m.

CHURCHILL-REDMAN 8¼in. Model C.R16, all-geared Norton type gearbox, vee bed, single pulley, for motor drive, taper turning attachment, swing over bed 16¼in., distance between centres 48in., hole through spindle 1⅜in., 16 spindle speeds, 12-487 r.p.m.

HOLBROOK 8¼in. Type T.17, motor drive, with taper turning attachment, swing over cross slide 10¼in., distance between centres 48in., 12 speeds, 8-400 r.p.m.

BETTS-NEWTON 14in. all-geared head, Norton type gearbox, geared taper turning, height of centres 14in., swing over bed 27in., swing over saddle 17¾in., dist. between centres 10ft., hole through spindle 2¾in., 9 speeds, 7-166 r.p.m.

CRAVEN 15¼in. Heavy Duty, all-geared head with motor drive and push-button control two saddles, each with rapid power traverse along the bed by separate motor, height of centres 15¼in., admits between centres 14ft. 6in., swing over saddles 20in., 16 spindle speeds, 1·5-145 r.p.m., approx. net weight 8 tons.

LANG 15¼in. Heavy Duty, all-geared head single saddle, sine bar type taper turning attach., height of centres 15¼in., dist. between centres 15ft., swing over saddles 20in., 12 forward speeds, 8·5-403 r.p.m., 4 reverse speeds, 16-338 r.p.m., h.p. of motor 20.

LANG 16in. Long bed, all-geared head, two saddles, push-button control, taper turning attach., height of centres 16in., distance between centres 23ft., 12 spindle speeds, 2-50 r.p.m., hole through spindle 3in.

CRAVEN 18in. Heavy Duty, motor drive and push-button control, height of centres 18in., admits between centres 11ft. 6in., swing over cross slide 18in., 12 spindle speeds, h.p. motor 25, with T.T. attachment.

DARLING & SELLERS 18/72in. Break Bed Lathe, motor drive, rapid power traverse to bed by separate motor, swing over bed 36in., swing over saddle 24in., swing in gap 72in., distance between centres 8ft. 6in., 12 spindle speeds, 1·66 r.p.m., h.p. of motor 35.

FAIRBAIRN, LAWSON, COMBE & BARBOUR 18in. S.S. and S.C. Lathe, all-geared head with motor drive, quick change feed box, rapid power traverse to saddle by separate motor, geared taper turning attachment, height of centres 18in., distance between centres 18ft., 24 spindle speeds, 1·08-152 r.p.m.

SCOTTISH MACHINE TOOLS (HARVEY) 20in. S.S. and S.C. Lathe, all-geared head with motor drive, quick change feed box, rapid power traverse to saddle by separate motor, height of centres 20in., distance between centres 9ft. 6in., 12 spindle speeds, 6·6-225 r.p.m.

LANG 24in./30in. swing oil country lathe, motor drive, all geared head, quick change feed box, duplex taper turning attach. Swing over saddle 20in., admits between centres 8ft., hole through spindle 10¼in., 8 spindle speeds 8-170 r.p.m., h.p. of motor 20.

CRAVEN 48¼in. Heavy Duty, motor drive through 4-speed gearbox to 4-speed all-geared headstock, giving 16 spindle speeds, six Duplex saddles, 3 front and 3 rear, each with rapid traverse motor, taper turning on all saddles, height of centres 48¼in., distance between centres 98ft. 6in., swing over saddles 71in., dia. of faceplate 8ft., dia. of faceplate on tailstock 6ft. 9in., 16 spindle speeds, 0·7-42 r.p.m., h.p. of motor 120.

VERTICAL BORERS

BULLARD 24in. Spiral Drive, single column, motor drive, turret head and side head, with square toolpost, table dia. 24in., max. swing 26in., height admitted 20¼in., 8 speeds 7·8-145 r.p.m.

BULLARD 36in. Spiral Drive, single column, motor drive, turret head and sidehead with square toolpost, table dia. 34in., max. swing 38in., height admitted 24in., 12 speeds 4·7-77 r.p.m.

RICHARDS 36in. Double Column, motor drive, two swivel toolheads and pentagon side toolholder, table dia. 34in., max. swing 36in., height admitted 30in., 12 speeds 1·88-45 r.p.m.

RICHARDS 36in. Double Column, motor drive, two swivelling tool rams, left hand fitted for screwcutting, table dia. 34in., max. swing 36in., height admitted 29in., 12 speeds 2·5-60 r.p.m.

GISHOLT 42in. Double Column, motor drive, two swivel tool heads, table dia. 40in., max. swing 48in., height admitted 33in., 12 speeds 2-60 r.p.m.

HARTMANN 43¼in. Single Column, motor drive, hexagonal turret head and sidehead with square toolpost, table dia. 39¼in., max. swing 43¼in., height admitted 27¼in., 16 speeds 3-52 r.p.m.

RICHARDS 48in., Double Column, motor drive, two swivelling tool rams on cross rail, diameter of table 44in., max. swing 48in., height admitted 33in., 6 speeds 2·22-34·7 r.p.m.

ARMSTRONG-CRAVEN 50in. Double Column Type, two swivel tool rams, table dia. 50in., max. swing 41in., max. height under cross rail 38in., 18 speeds 2-45 r.p.m.

OLBURN 60in. Double Column Type, two swivel rams, table dia. 60in., max. swing 62in., max. height under cross rail 46in., 10 speeds 2-37 r.p.m.

HORIZONTAL BORERS

KEARNS 'S' Type, with collet type spindle, motor drive, with separate motor for table feeds, table size 22in. by 16in., long. table traverse 24in., cross table traverse 12in., vert. adjustment of spindle slide 12in., 6 spindle speeds 80-1,000 r.p.m.

KEARNS No. 1 Standard Type, motor drive, facing head only, max. facing cap. 20in., sliding table 33in. by 24in., revolving top table 24in. by 24in., max. distance facing head to outer stay 4ft., 24 speeds 4-300 r.p.m.

KEARNS No. 2 Patent Type, motor drive, with traversing spindle and continuous automatic facing head, main table with detachable quartering table, vernier scales, outer boring stay, spindle dia. 3in., facing capacity 30in., main table 48in. by 30in., auxiliary top table 36in. by 36in., 24 spindle speeds, 3·1-250 r.p.m., h.p. of motor 5.

PEARN-RICHARDS No. 4 Standard Type, motor drive, facing head only, max. facing capacity 48in., sliding table 60in. by 36in., revolving top table 36in. by 36in., max. distance facing head to outer stay 7ft. 7in., 32 speeds 1·5-160 r.p.m.

SCHARMANN HBSF3, motor drive, facing head, power feeds and rapid power motion to table and spindle, screw-cutting and verniers, dia. of spindle 4in., travel of spindle 31½in., facing cap. 39½in., boring capacity 19¼in., working surface of table 47½in. by 55½in., max. distance spindle nose to outer stay 102½in., 24 spindle speeds, 4·7-960 r.p.m., h.p. of motor 10.

NILES WV9 Floor Type Horizontal Borer, flanged motor drive, spindle dia. 3½in., facing head dia. 24½in., travel of spindle 31½in., travel of column 4ft. 4in., max./min. distance baseplate to spindle 60in./18in., 16 speeds 3-350 r.p.m.

GRINDERS

SURFACE

PRATT & WHITNEY 14in. Vertical Spindle Hydraulic Surface Grinder, multi-motor drive, reciprocating table, capacity 36in. by 12in. by 16in., table surface 36in. by 12in., grinding wheel dia. 14in., table speeds (infinitely variable) 3-100ft.p.m.

SNOW Model VB18 Vertical Spindle, motor drive, table working surface 72in. by 15in., dia. of segmental wheel 18in., table traverse 83in., max. height wheel to table 18in., table speed variable up to 50ft.p.m.

SNOW P24, Horizontal Spindle, motor drive, table working surface 24in. by 8in., table traverse 28in., max. height admitted 8¼in., table speed variable up to 100 ft.p.m.

CYLINDRICAL

LANDIS Type "C" Universal Grinder, motor drive, max. swing 10in., admits between centres 24in., internal grinding attachment.

INTERNAL

CHURCHILL No. 1 Internal Cylinder Grinder, motor drive, max. dia. of planetary stroke 1⅛in., max. centre ht. over table 12⅛in., min. centre ht. over table 4½in., table size 38in. by 12½in., 2 planetary motion speeds, trav. speeds hydraulically variable up to 12ft.p.m.

CHURCHILL Model HBY Internal Grinder, motor drive, max. swing inside water guard 12in., max. swing over table 19in., max. traverse of table 24in., total h.p. 6.

CHURCHILL Model HCY Internal Grinder, motor drive, max. swing inside water guard 16in., ht. of centres 11in., table size 66in. by 13in., total h.p. required 6.

CHURCHILL Model HDY Internal, motor drive, max. swing inside water guard 20in., max. swing over table 25in., max. traverse of table 32in., total h.p. 6.

SPLINE

DEMM Model RS1400, motor drive, distance between centres 55½in., max. dia. ground 3⅞in., max. length ground 39½in., height of centres 5½in., spindle speed 3800 r.p.m., hole through spindle 3⅛in.

CAPSTANS & TURRETS

CAPSTANS

GISHOLT No. 4 Ram Type Turret, all-geared head, motor drive, power feeds to cross slide and turret, for chuck work, spindle bore 2⅛in., swing over bed 18½in., swing over cross slide 9⅜in., spindle nose to turret face 26in., 12 spindle speeds 28-730 r.p.m.

GISHOLT No. 5 Ram Type Turrets, all-geared head, motor drive, power feeds to cross slide and turret, for chuck work, spindle bore 2⅝in., swing over bed 19¾in., swing over cross slide 10⅝in., spindle nose to turret face 30in., 12 spindle speeds 28-730 r.p.m.

TURRETS

GISHOLT 1L., motor drive, power feeds to turret and cross slide, arranged for chuck work, spindle bore 3⅛in., swing over cross slide 14¼in., 12 spindle speeds 20-486 r.p.m.

MAGDEBURG RSR.520, motor drive, all-geared head, power feeds to turret and cross slide, spindle bore 3¼in., swing over bed 22⅝in., max. distance spindle nose to turret face 49½in., speed range 9·6-480 r.p.m.

WARNER & SWASEY 2A, motor drive, all-geared head, power feeds to turret and cross slide, spindle bore 3¼in., swing over bed 20in., max. distance spindle nose to turret face 51¼in., 12 spindle speeds 17-460 r.p.m.

WARNER & SWASEY 3A, motor drive, all-geared head, power feeds to turret and cross slide; spindle bore 4¼in., swing over bed 23¾in., max. distance spindle nose to turret face 58¾in., 12 spindle speeds 12-314 r.p.m.

PLANER

LOUDON 13ft. by 5ft. by 5ft. Double Column Machine, with Lancashire Planer Drive, two swivelling tool boxes on cross rail, width of table 4ft. 6in.

HEAVY DUTY SLOTTERS

BUTLER 8in. High Production, motor drive, with automatic and hand long., cross and rotary table movements, max. length of stroke 8in., table dia. 20in., dia. admitted 24in., ram face to frame 12in., table traverse long. and cross 15¼in., 4 ram speeds, 31-90 strokes/min., h.p. of motor 5.

ORMEROD 8in. High Production, motor drive, with automatic and hand long., cross and rotary table movements, max. length of stroke 8in., table diameter 18in., max. diameter admitted 30in., long./cross traverse of table 13¾in./15¼in., 4 ram speeds, 23-71 strokes/min., h.p. motor 4.

BUTLER 12in. High Production with tilting body, motor drive, with automatic and hand long., cross and rotary table movements, max. length of stroke 12in., table diameter 30in., max. diameter admitted 42in., long./cross traverse of table 24in./24in., 4 ram speeds, 21-61 strokes/min., h.p. of motor 7½.

BUTLER 28in. High Production, with electric feed unit and power traverse, enabling control of the machine to be made from the operator's push-button station, ram balanced by counterweight, max./min. stroke of ram 28/10in. dia. admitted 5ft. 9in., gap 3ft. 9in., table traverse long. or cross 3ft 6in., table dia. 5ft., h.p. of main motor 20.

There is a second machine of this size available, but with separate motor for power traverse in place of the electric feed unit.

BUTLER 30in. High Production Slotter, with separate motor drive to ram, table feeds and power traverse, ram balanced by counterweight, multi-cee slotted ram face, length of stroke max./min. 30in./12in., No. of speeds 6, speed cycle from 7 to 24 p. min., ram face to frame 3ft. 9in., ram to table max. distance 5ft. 3in., table traverse, long. (across from centre) 3ft. 6in., table traverse, trans. (in and out) 3ft. 6in., table dia. 5ft., h.p. main motor 20, h.p. feed motor 5.

RADIAL DRILLS

ARCHDALE 6ft. Medium Duty, centralised control, multi-motor drive, with removable box table, max. spindle radius 6ft., max. distance spindle to baseplate 6ft., M.T. in spindle 5, capacity in C.I. 2¼in., capacity in M.S. 2in., 12 spindle speeds, 60-1500 r.p.m., h.p. of motors 5 and 5. Two available.

ASQUITH 3ft. 6in., LDR Type Radial, multi-motor drive, max. drilling radius, 3ft. 6in., max./min. spindle to baseplate 4ft./1ft. 4in., 12 spindle speeds, 70-2000 r.p.m., 6 feeds, 30-180 c.p.i., M.T. in spindle 4, total h.p. 5.

ASQUITH 3ft. 9in. Portable, motor drive, drilling head adjustable in horizontal and vertical planes to any angle, max. drilling radius 3ft. 9in., max. distance from floor to spindle, vertical drilling 5ft., horizontal drilling 7ft., 6 spindle speeds, 41-300 r.p.m., 2 feeds, 150-200 c.p.i.

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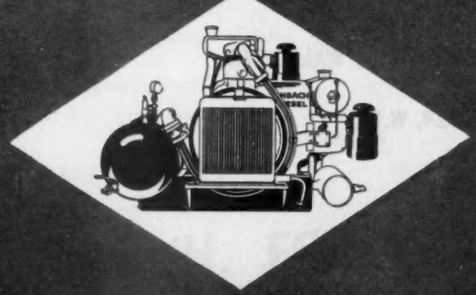

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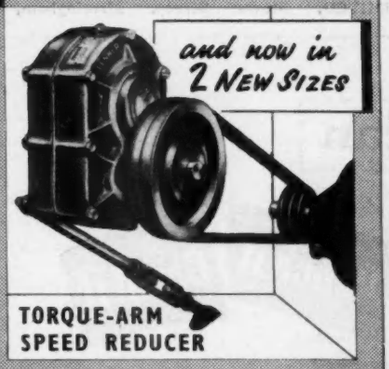

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C. S. HANDLEY (*Assistant London Regional Manager*)	May 11th, 12th, 16th, 17th, 19th
J. MORGAN (*Newcastle Branch Manager*).. ..	May 9th, 10th, 11th

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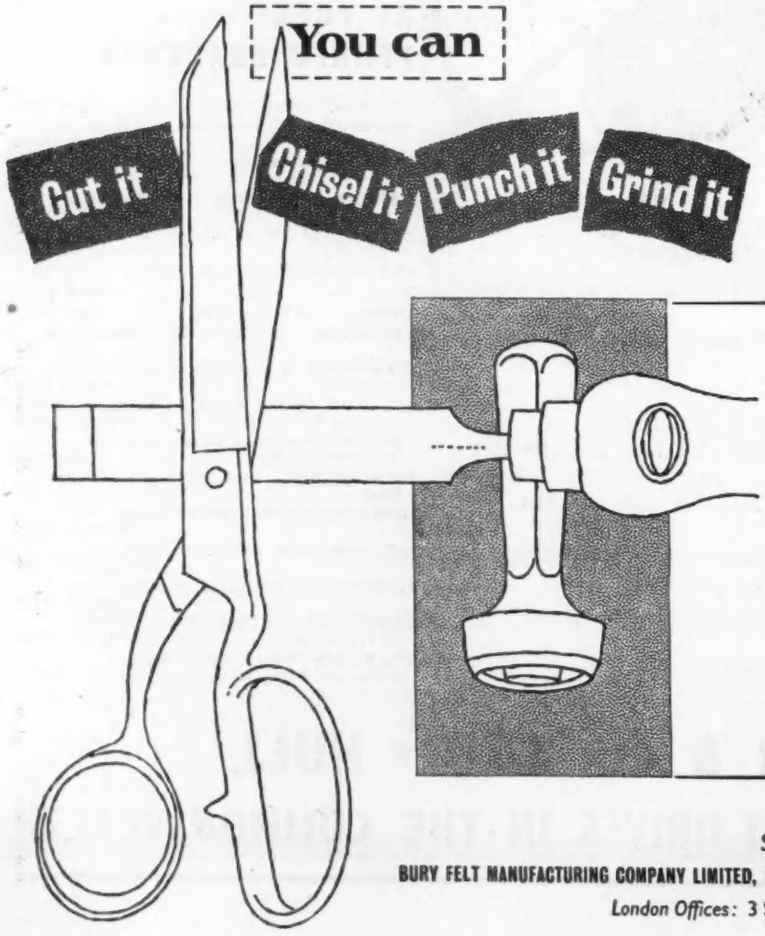

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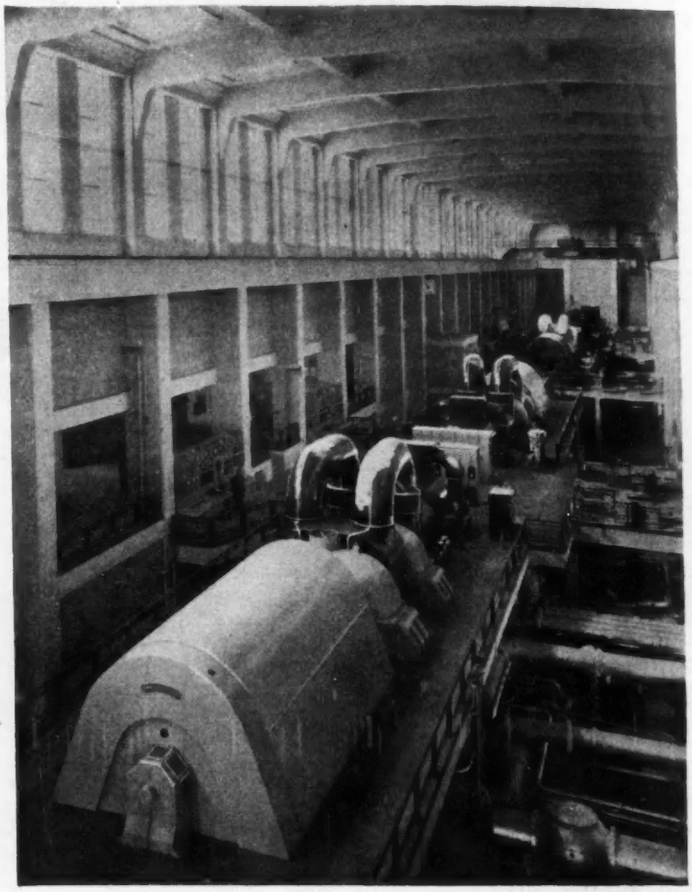

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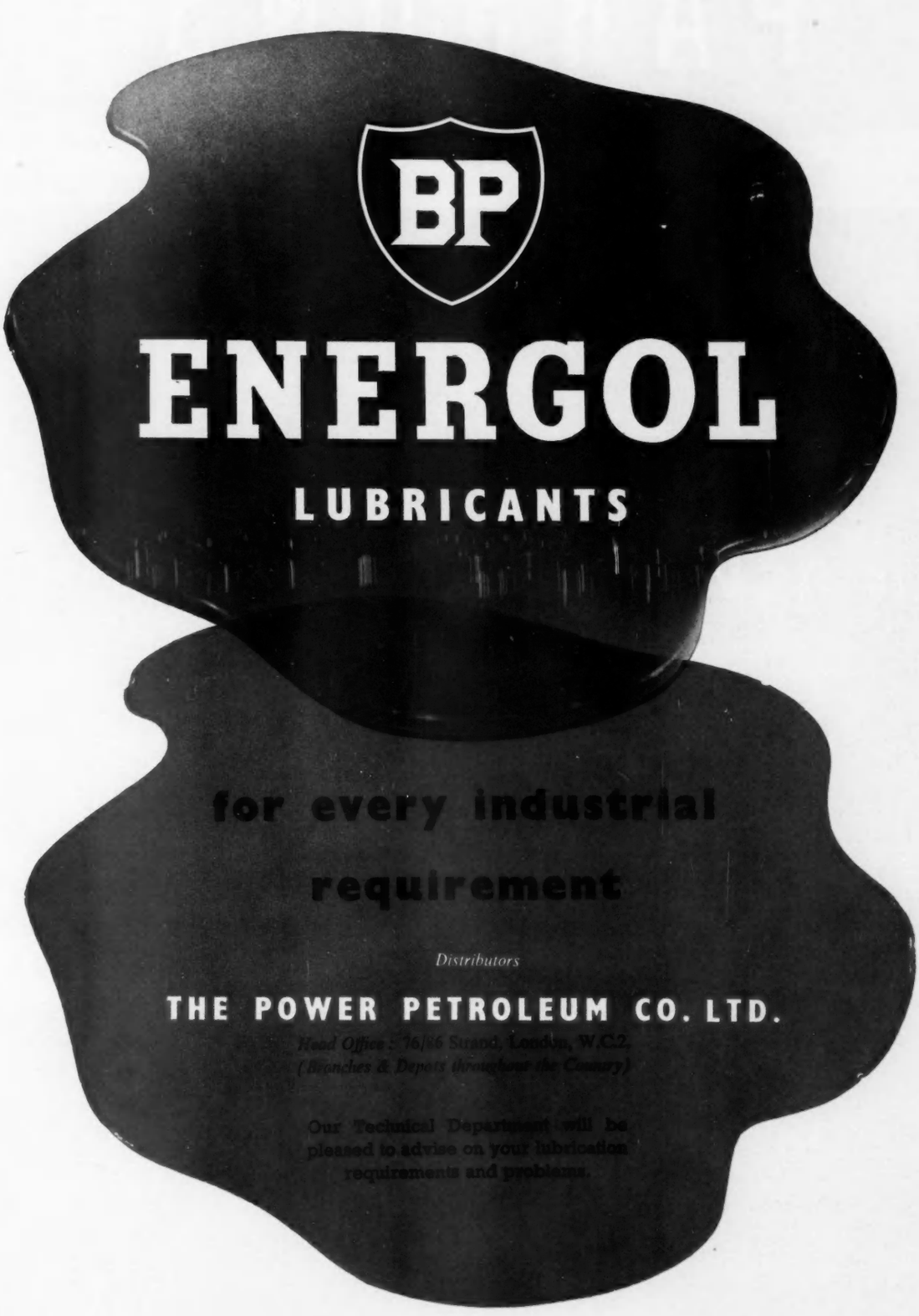
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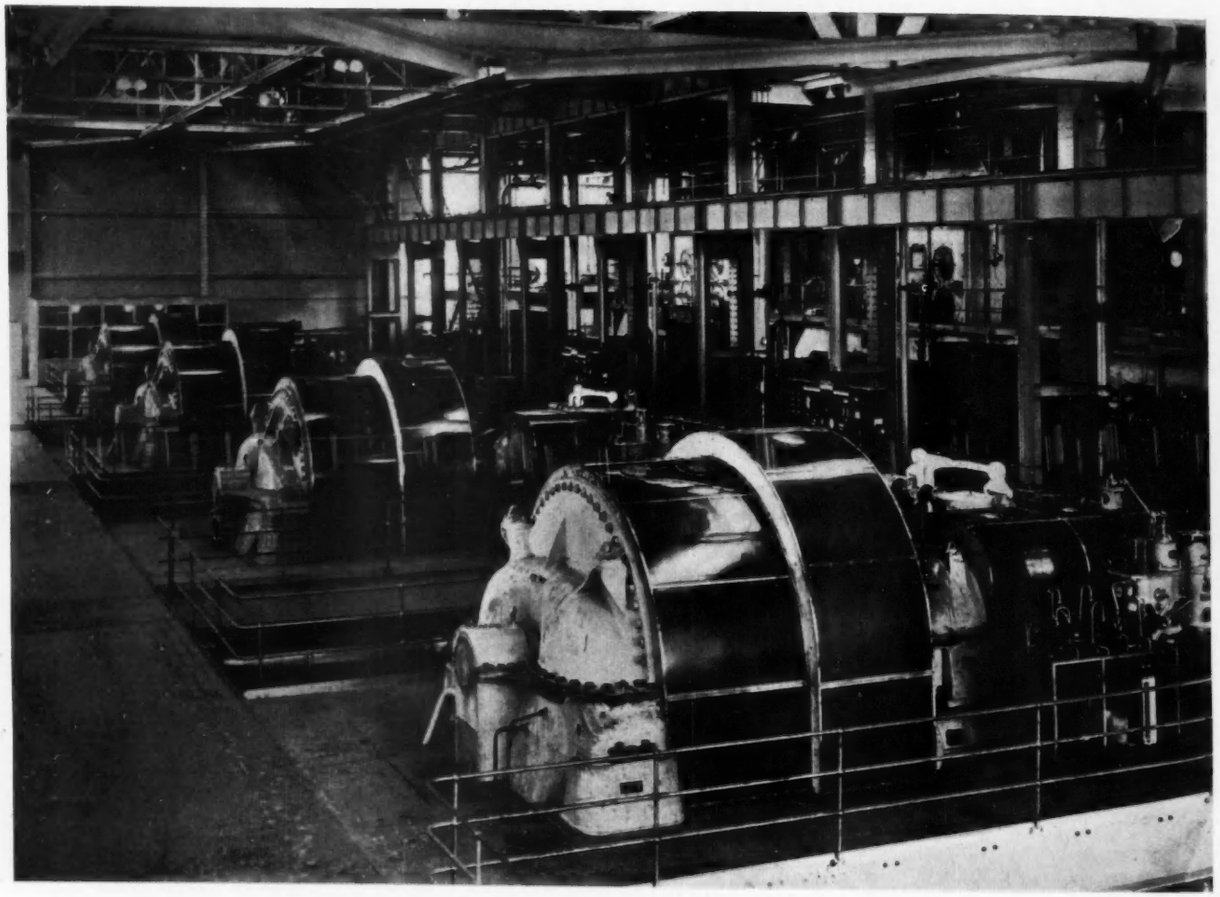

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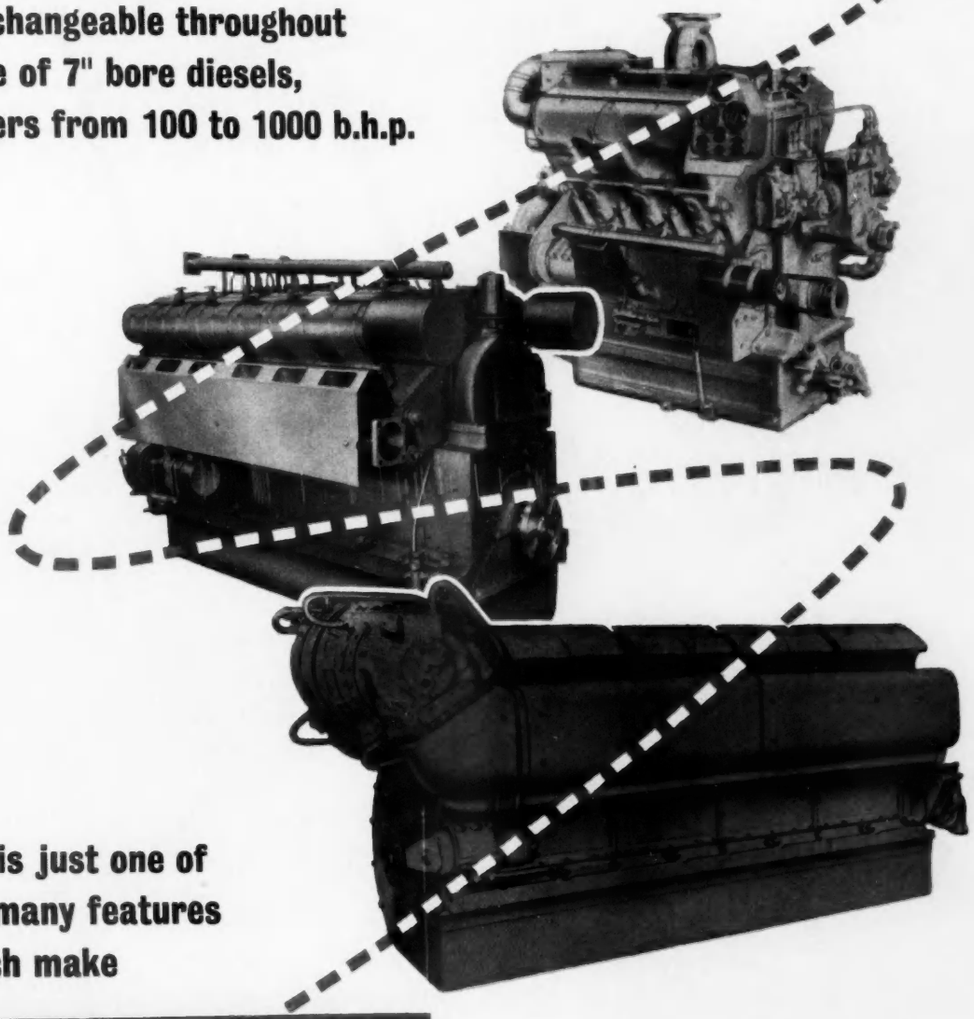

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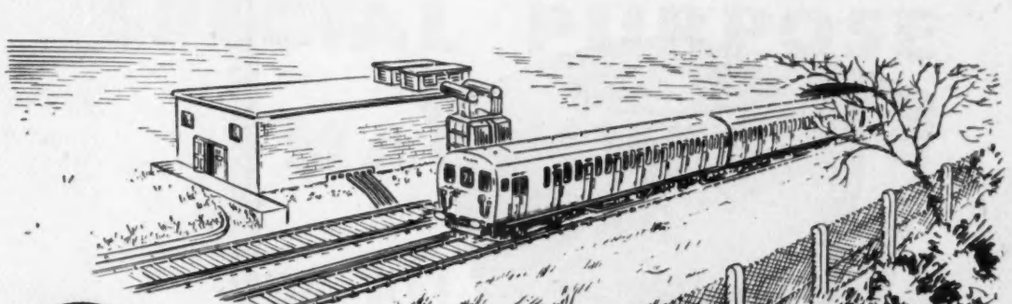

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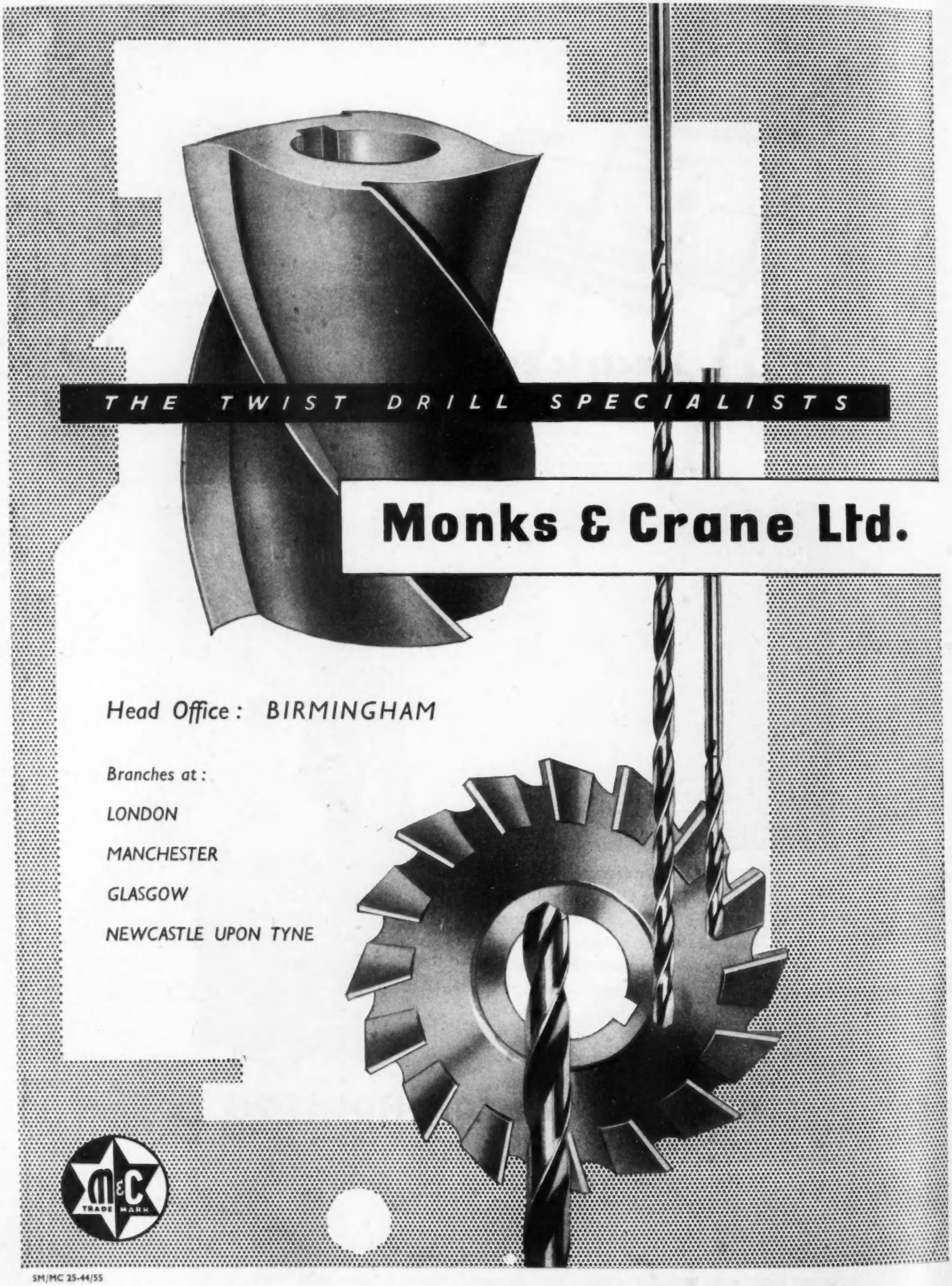
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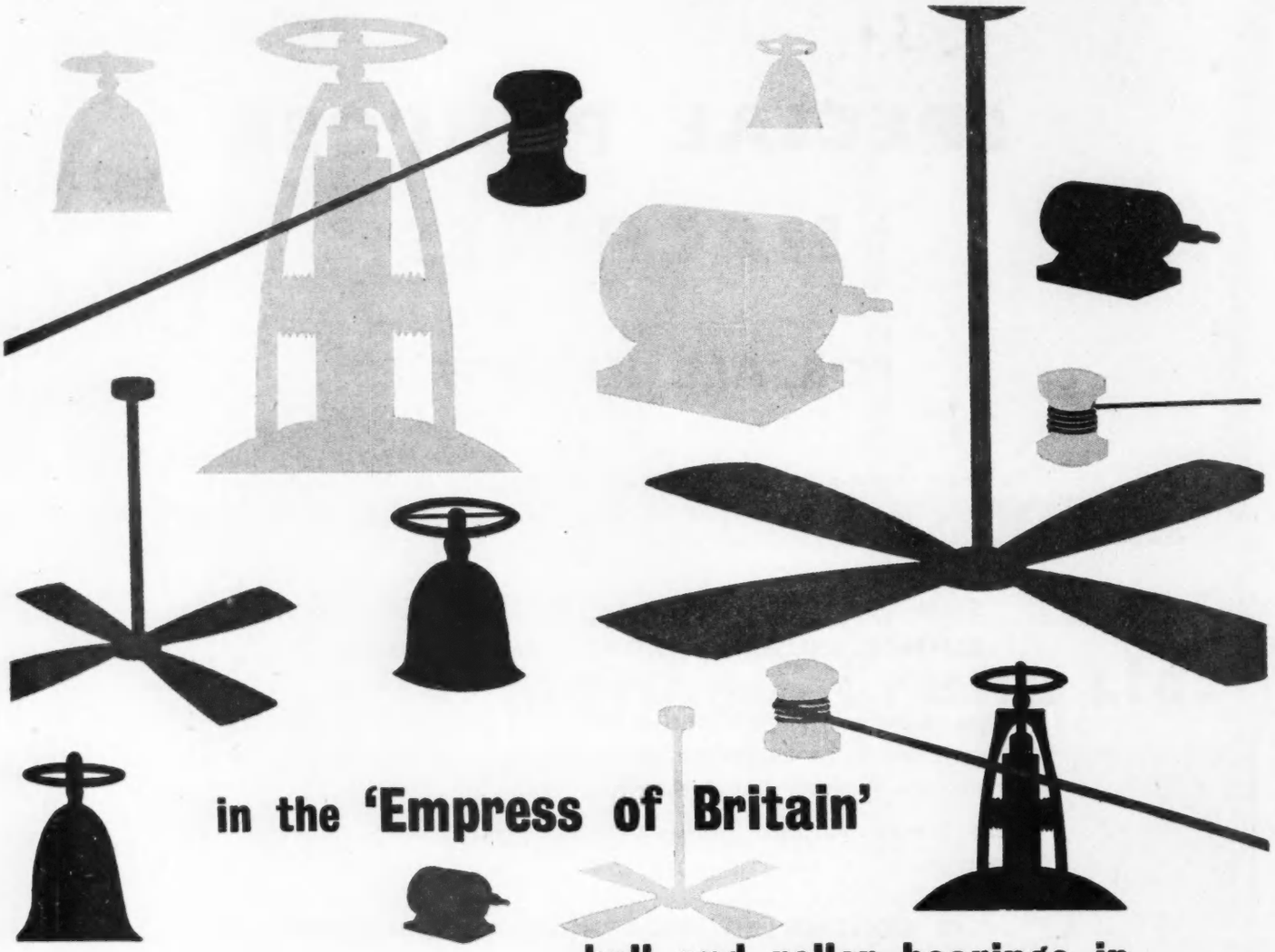

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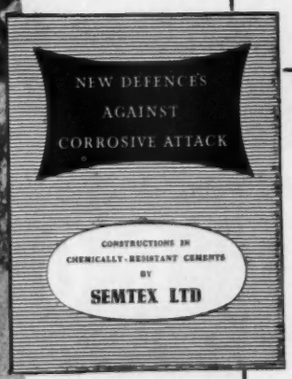

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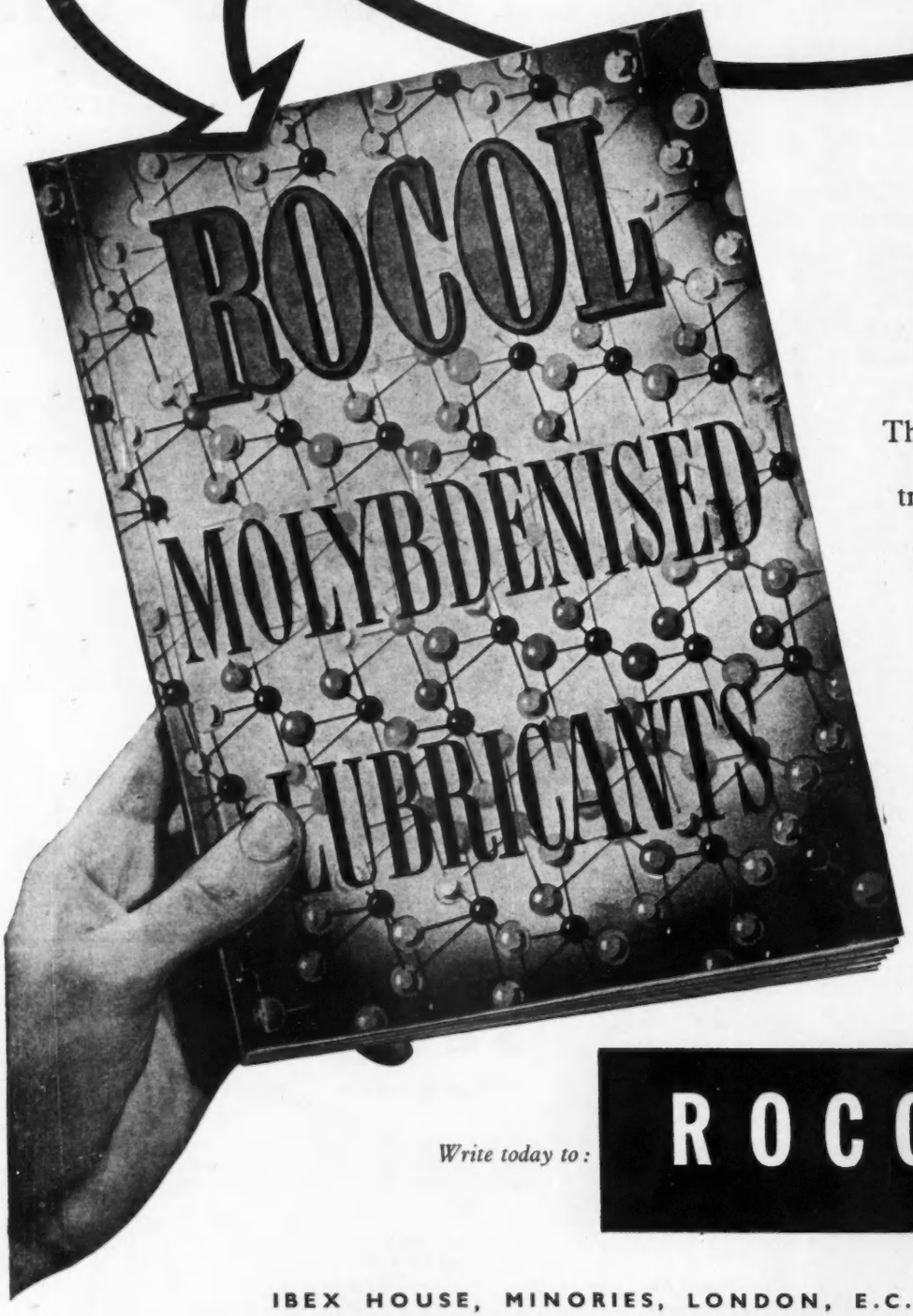

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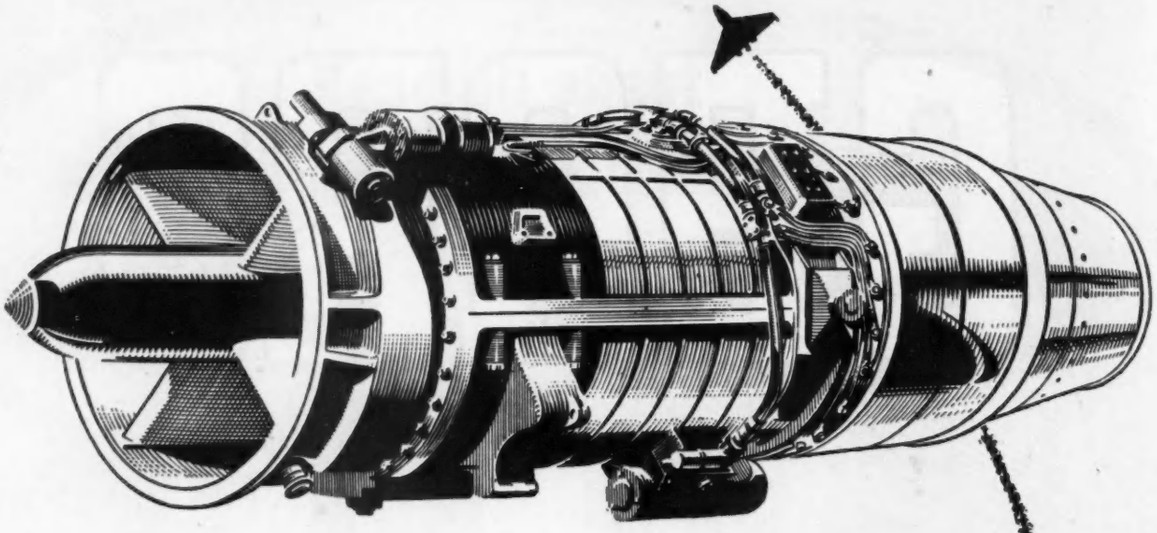

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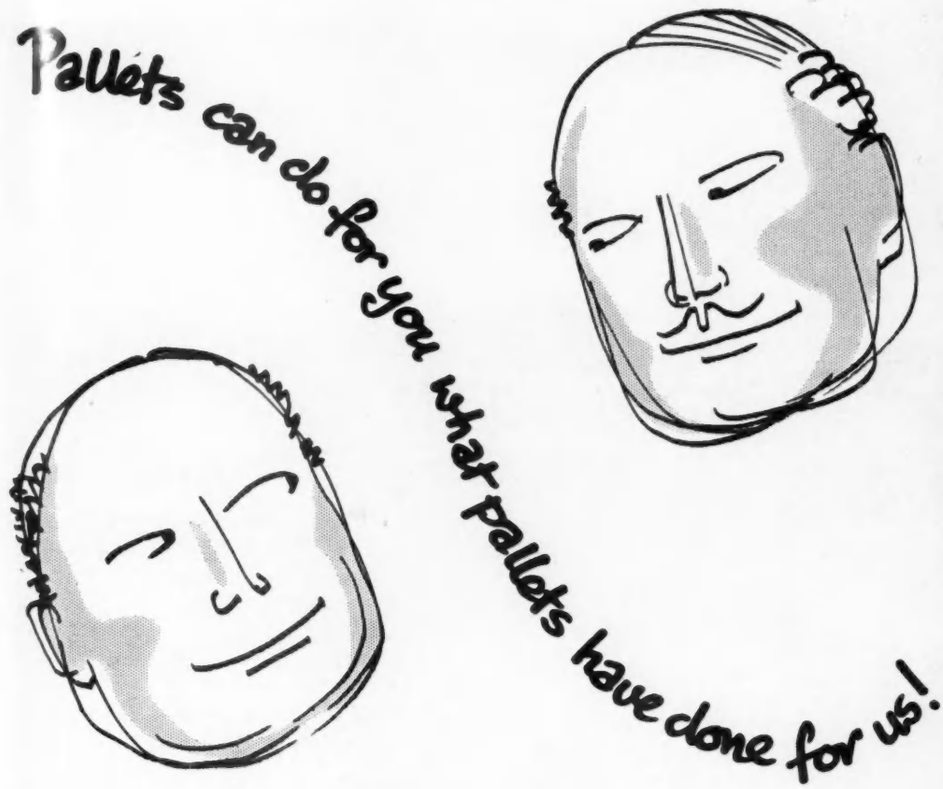

It's not surprising that palletisation has caught on and become good business. Once the word got around that in nearly every industry and type of work, big money could be saved in time, labour, space and damage by using modern materials-handling techniques, manufacturers the world over seized the opportunity to streamline their production economics. There are, of course, pallets and pallets . . . the best by far are *welded steel*, made at Stourbridge. Write for literature and details of our design service.

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Post-type pallet with loose sides, for sacked or bagged goods.
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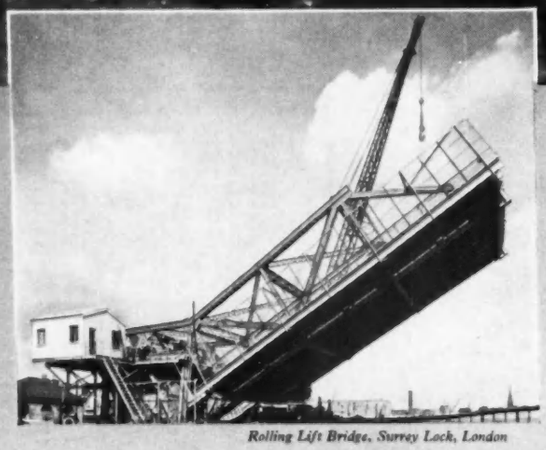

Rolling Lift Bridge, Surrey Lock, London

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Strength and fitness for purpose distinguish the many types of bridges built by ARROL of GLASGOW. From the Forth, Tay and Tower bridges of the 19th century to those now under construction at Conway in North Wales and at Samawa on the river Euphrates, a long tradion of achievement can be clearly traced.

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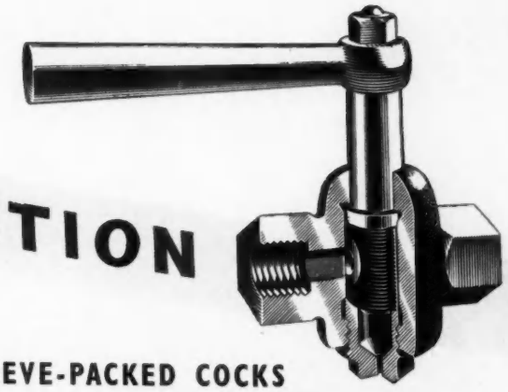
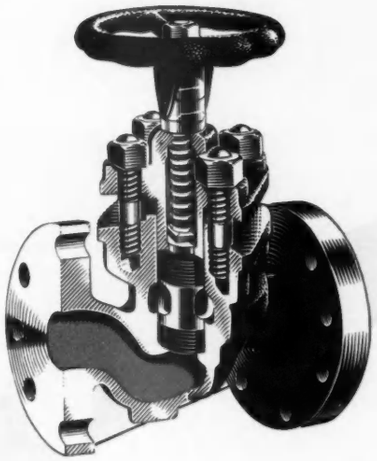


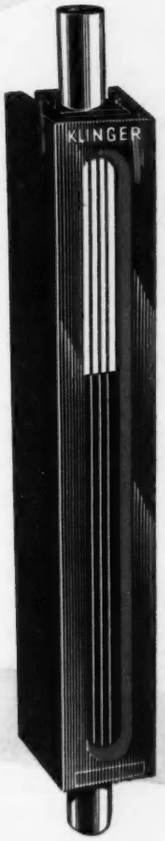
PRODUCTION FLOWS

KLINGER SLEEVE-PACKED COCKS

In the last quarter of a century Klinger Sleeve-Packed Cocks have steadily replaced the old-fashioned asbestos-packed cocks with their limitations of working pressures, difficulty of repacking and tendency to jam. They are available in a wide range of designs and sizes for all purposes and pressures, and with the following advantages:—
Renewable "Klingerit" packing sleeve. Parallel-ground non-jam plug. Retightening during use. Unobstructed straight-thru full-bore passage.



THROUGH



KLINGER SEATLESS PISTON VALVES

The Klinger Seatless Piston Valve operates on an entirely different principle from the usual type of seating valve. It consists basically of a finely ground piston, operated by the valve spindle and hand wheel and moving through two or three non-metallic resilient valve rings, capable of resisting steam, oil and most fluids at high temperatures and pressures, and separated by a ported lantern bush. It is made in a great variety of sizes and designs, to suit all purposes, and has the following advantages:—
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KLINGER FITTINGS

KLINGER REFLEX LEVEL GAUGES

The "K" Type Reflex Level Gauge has the following outstanding advantages:—
Single row of tightening bolts. Body free from distortion. Glass easily removed. Gauge body turnable, free to expand, and easily removed.
The "K" Type Gauge is made in a wide variety of sizes and any number of bodies can be combined to provide level indicators of any length.

Write for the Klinger Master Catalogue which describes the complete range of Klinger products.

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See this impressive new machine
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It has many features not previously incorporated in cranes of this type.
Friction clutches of entirely new design for speedy working.
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Steel Cab of latest type.
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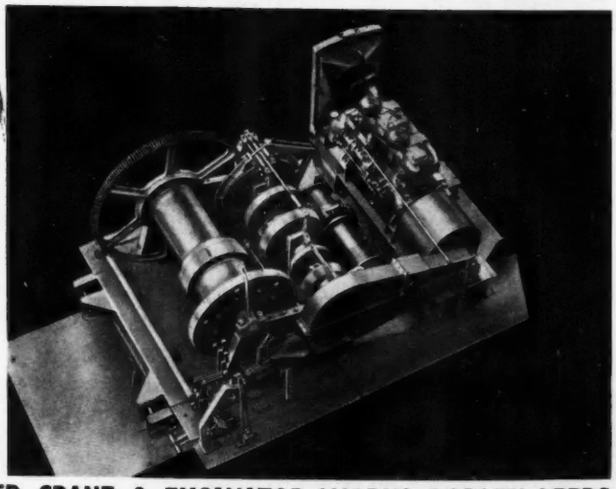
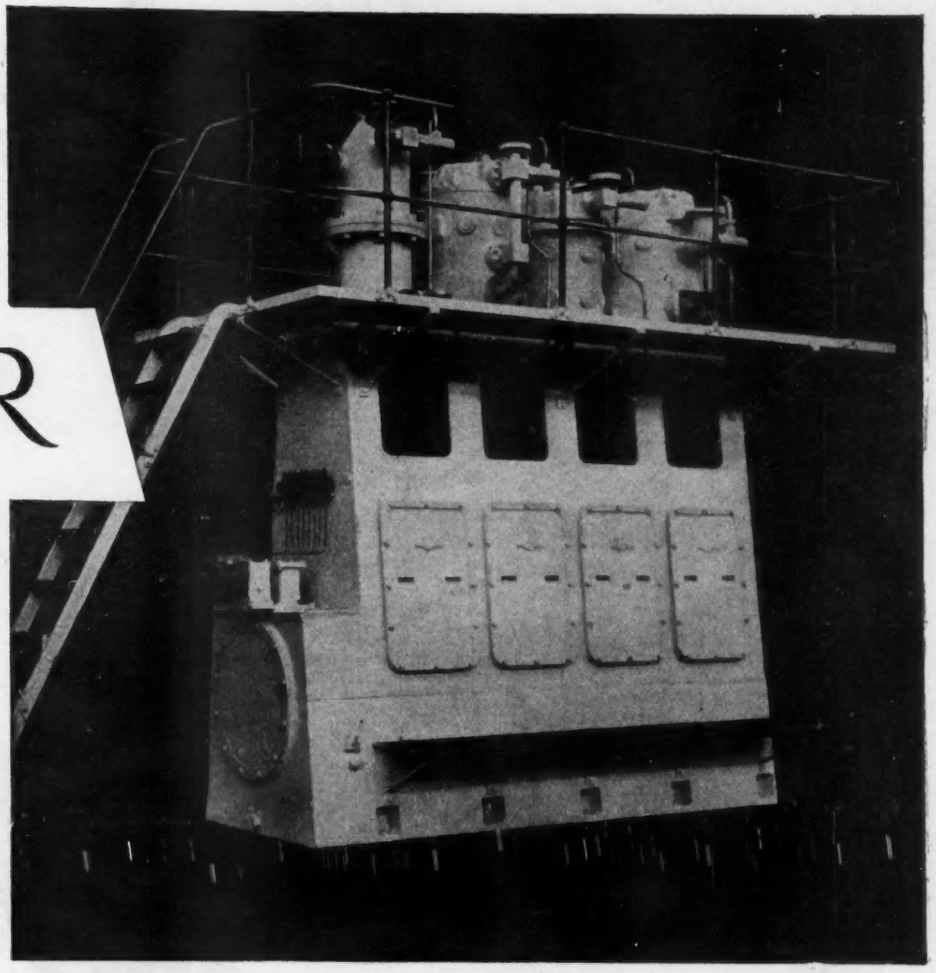
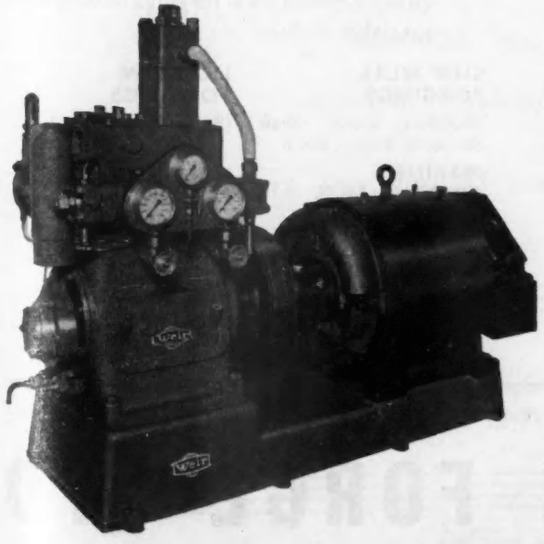


THOMAS SMITH & SONS (RODLEY) LTD CRANE & EXCAVATOR WORKS RODLEY LEEDS



WEIR

High Pressure COMPRESSORS



Air and Gas Compressors for all industrial purposes requiring high pressures.

Electric, diesel, or steam engine driven high pressure compressors for marine use.

Normal pressures 350 to 600 lb./sq. in. Higher pressures supplied as required.

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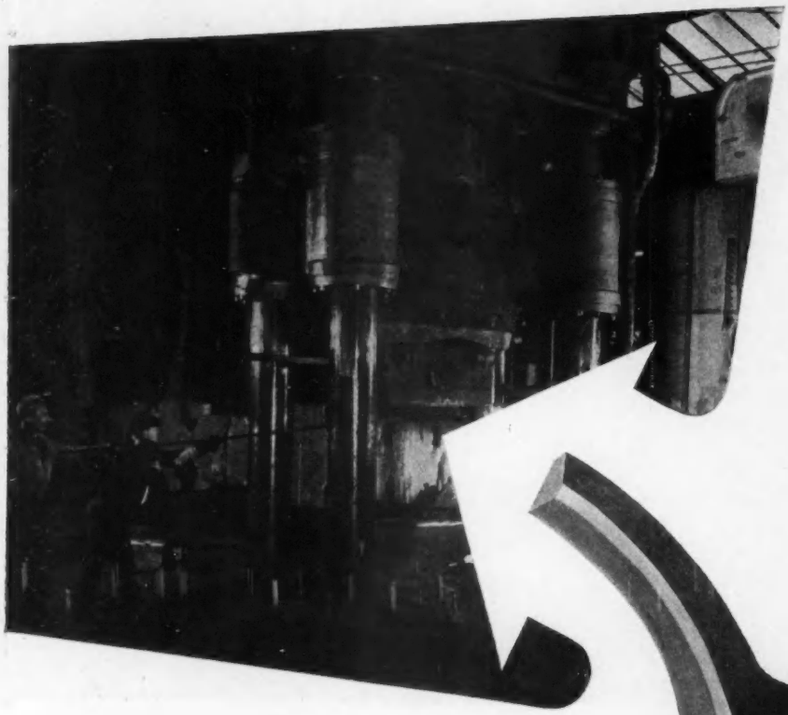
Forgings for



Marine and General Engineering

The forged steel sole piece illustrated, 19 ft. in length and weighing nearly 8 tons, was supplied recently for incorporation in a part fabricated ship stern-frame.

Other types of steel forgings in which we specialise include.—

SHIP HULL FORGINGS
(Rudders, Stocks, Shaft Brackets, Tillers, etc.)

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(Finished and rough machined)

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ELECTRICAL AND GENERAL STEEL FORGINGS

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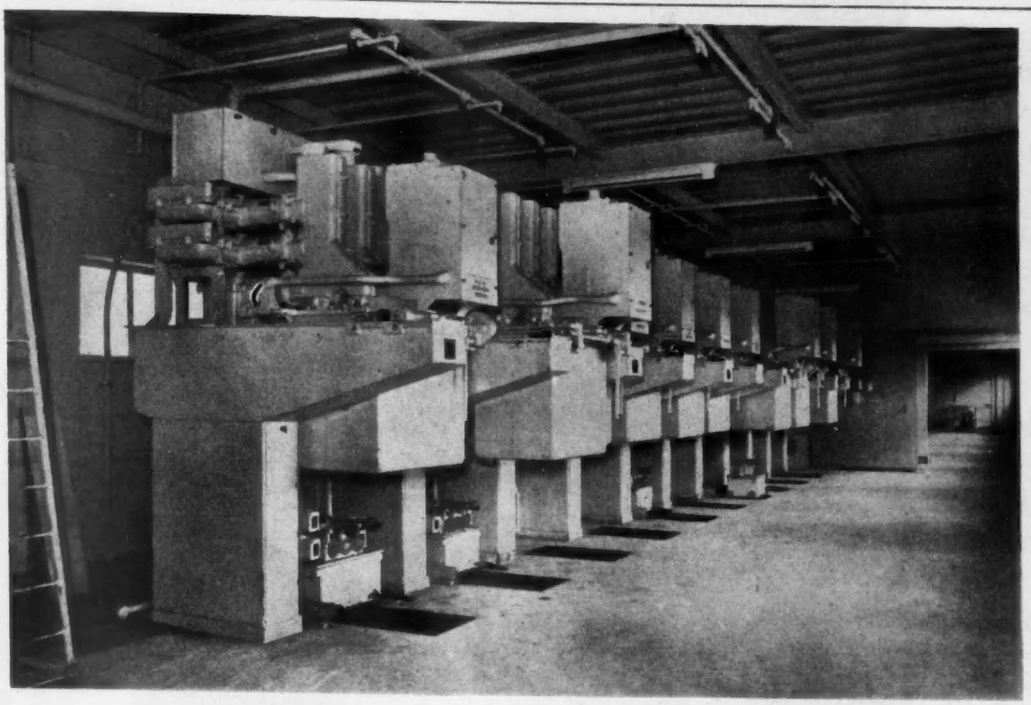


Switchgear for Steelworks

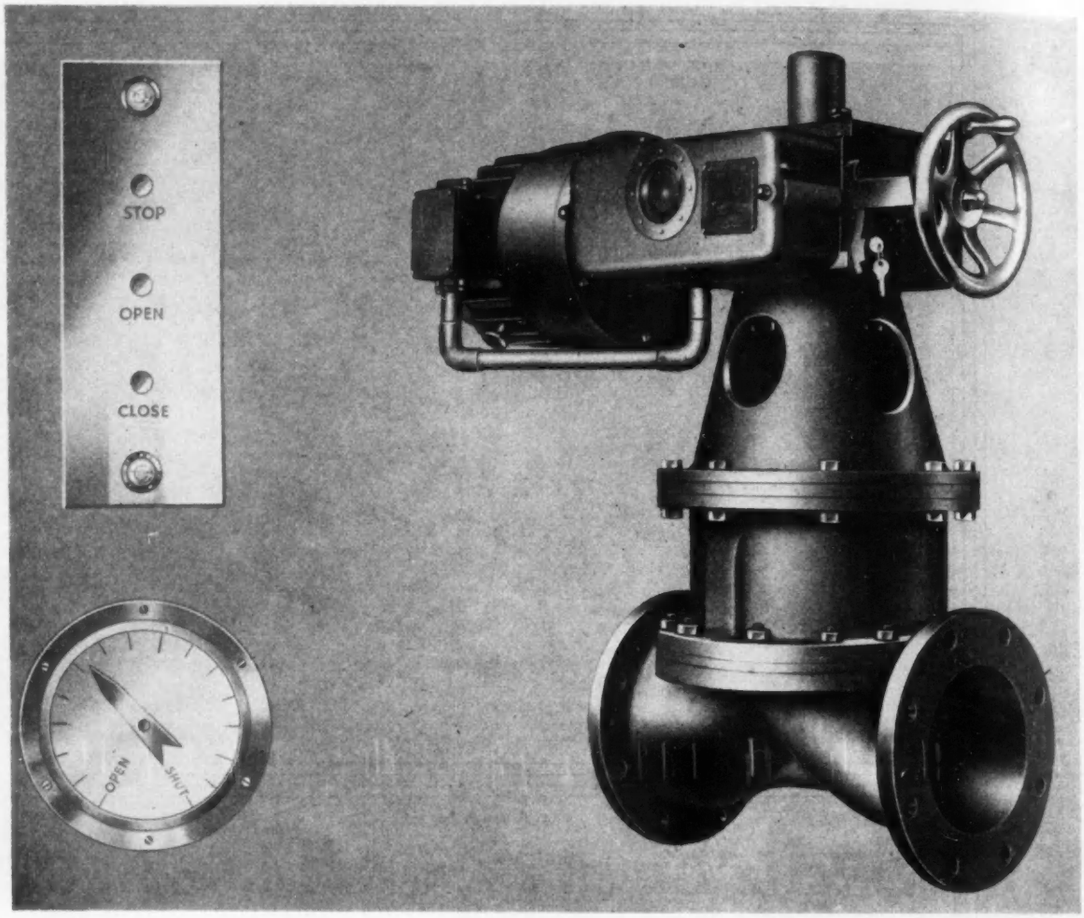
The 11-kV distribution network and the two 9,000-H.P. motor-generators for the main mill drives of Richard Thomas and Baldwins' Ebbw Vale No. 5 Stand Mill are controlled by Reyrolle metalclad switchgear of the type illustrated.

A. REYROLLE AND COMPANY LIMITED HEBBURN COUNTY DURHAM ENGLAND

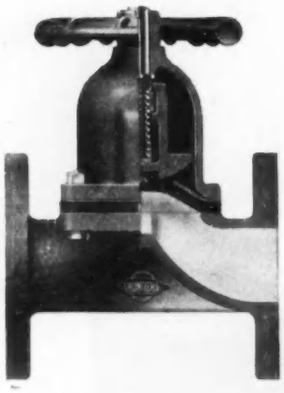
Consulting Engineers: McLellan and Partners

SPECIALISTS IN SWITCHGEAR FOR OVER HALF A CENTURY

Reyrolle



Electrically Operated



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SAUNDERS DIAPHRAGM VALVES

Direct electric actuation with either local or remote control. 2 b.h.p. motor of ½ hour rating. Micro-switch control for open and closed positions. Mechanical position indicator incorporated. Sizes 6″, 7″, 8″, 10″ and 12″.

SAUNDERS VALVE COMPANY LIMITED

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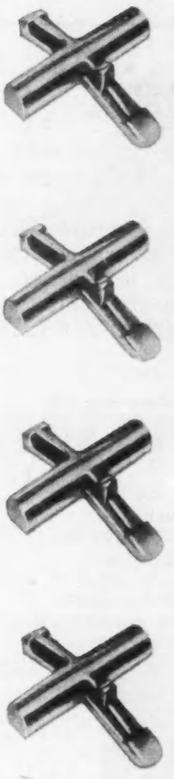
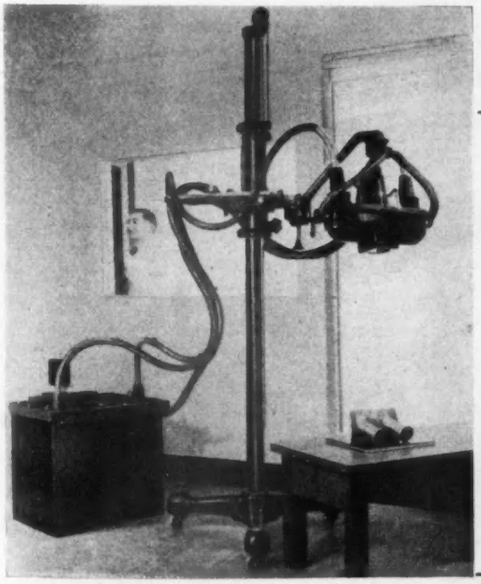
One of these is faulty...



The problem of detecting faults at the earliest stages of production has found a ready solution in many industries with Newton Victor X-Ray Testing Equipment. There are Newton Victor units for every purpose and they are simple to operate even for employees without previous testing experience. Here is the modern, non-destructive method of testing which locates faults with maximum speed, precision and economy. Every unit in the Newton Victor range is robust and durable, and backed by outstanding service.



The Raymax 140 and ST16 Tube-stand Combination.

SEE it with

Newton Victor X-ray units

Newton Victor Limited

132 Long Acre, London, WC2.

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copying

To claim that copying costs come down with AZOFLEX is a bold statement — but one that happens to be very true. AZOFLEX photo-printing machines and materials provide the ideal means of producing inexpensive, high-quality facsimiles of drawn, typed or printed originals of all kinds — single or double-sided, translucent or opaque. Many important industrial, commercial and professional organizations have already proved the economy and effectiveness of the AZOFLEX process.

costs

The simplicity and cheapness of AZOFLEX are quite startling. With the Model 42/63 Mark II Combine Printing and Developing Machine illustrated here, for example, one *unskilled* operator need only feed originals and copying material into the machine in order to produce a steady output of finished prints, dried, flat and ready for trimming and collating. Exposing, developing and print delivery are completely synchronized.

come

With the AZOFLEX method, money is saved because not only does it eliminate the need for specialist operators, but neither darkroom accommodation nor water and drainage services are required, and the materials themselves are inexpensive. AZOFLEX also cuts costs by speeding up output and by giving copies of greatly improved quality even from poor originals.

down

There is a comprehensive range of AZOFLEX printing and developing machines and a wide variety of AZOFLEX photo-printing materials designed to meet the needs of every type of organization. AZOFLEX creates no mess or unpleasant smell, while the materials are very easy to handle and process.

with

Backed by all the photographic experience and skill of Ilford Limited, AZOFLEX materials are produced in the world's most up-to-date diazo coating plant and are remarkable for their long shelf life, intense line and resistance to fading.

For descriptive literature about AZOFLEX machines and materials, please apply to Ilford Limited, Azoflex Department AZ3D, 104 High Holborn, London, W.C.1 (Telephone: HOLborn 3401). Demonstrations of the Azoflex process can be seen at this address and also, by appointment, at Ilford Limited, 22 Lloyd Street, Manchester 2 (Telephone: Deansgate 4233) and in other principal cities.

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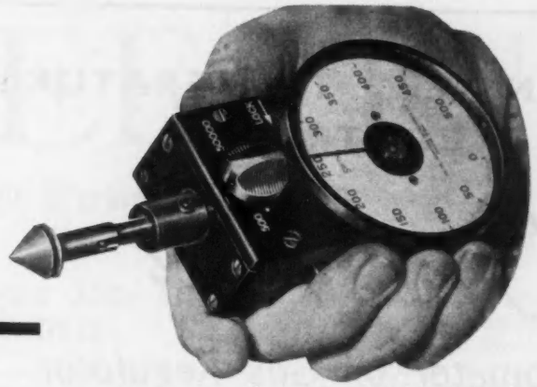
That most versatile Instrument — *the Hand Tachometer*

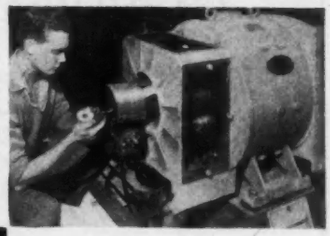


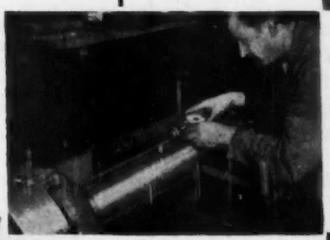
The SMITHS Hand Tachometer is used by such a wide variety of industries and trades and for so many different purposes, that to mention a few applications is but scratching the surface. Its users range from major industries to small workshops and include manufacturers of hair nets, toffee, umbrellas, slippers and—quite likely, candlestickmakers.

Briefly, Smiths Hand Tachometers provide a ready and accurate check on rotational and surface speeds. Their use is a safeguard against excessive wear of plant and uneconomical operation.

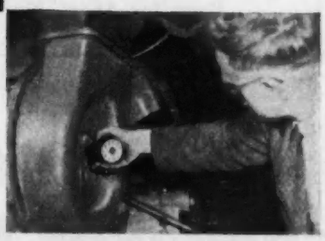
The Hand Tachometer serves Industry

A Hand Tachometer is shown here at a G.E.C. factory, measuring rotational speed during the normal testing of a 10 kW, 125 volt exciter.





In this instance, the English Steel Corporation Ltd. are using a Hand Tachometer to indicate the surface speed of a test bar during a turning tool investigation.

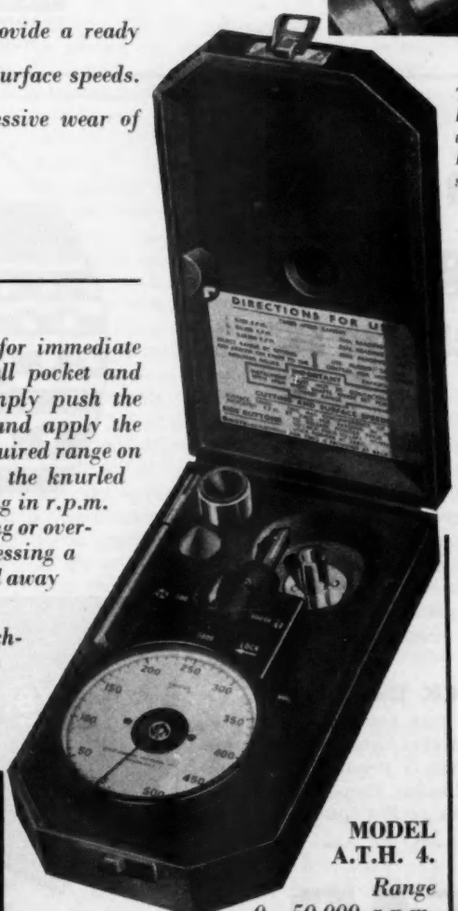


This picture shows a Hand Tachometer in use by 'English Electric' for rating superchargers.

Using the Hand Tachometer

The instrument is always ready for immediate use. It can be slipped into an overall pocket and carried as easily as a slide-rule. Simply push the appropriate attachment on to spindle and apply the instrument to the belt or shaft. The required range on each Tachometer is selected by turning the knurled knob and the dial gives the correct reading in r.p.m. or f.p.m. Under conditions of bad lighting or overhang, the pointer can be locked by depressing a button. The reading can then be observed away from the take-off point.

EACH SET COMPRISES Hand Tachometer, male rubber centre, female rubber centre, three-inch extension piece, disc for surface and cutting speeds (for reading in either feet or metres)



MODEL A.T.H. 4.
Range 0—50,000 r.p.m.

This versatile instrument is also used for

retiming diesels • press work • checking cutting speeds (especially during piece-working) • belt speeds • time and motion study • and for a thousand other purposes.

* *Accuracy ½% of the measured reading*
* *For either direction of rotation*
* *Will accept 100% overload*

MODEL A.T.H. 6.
Range 0—10,000 r.p.m.

MODEL A.T.H.7.
Range 0—20,000 r.p.m.

MODEL A.T.H. 10.
Range 0—5,000 r.p.m.

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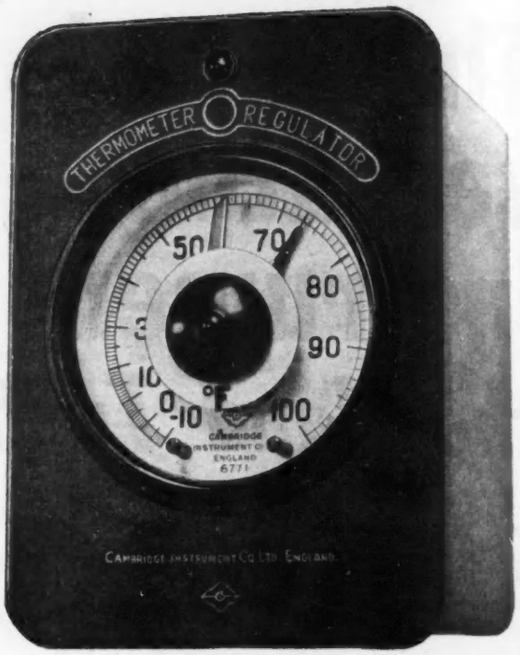

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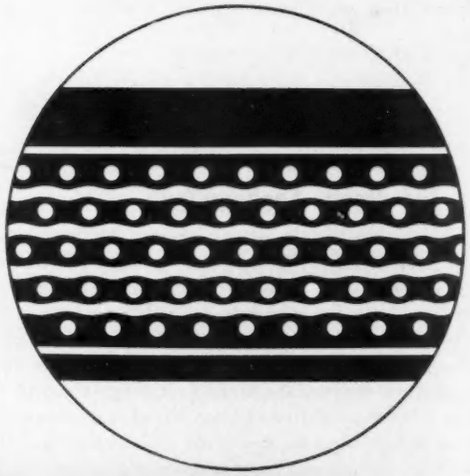

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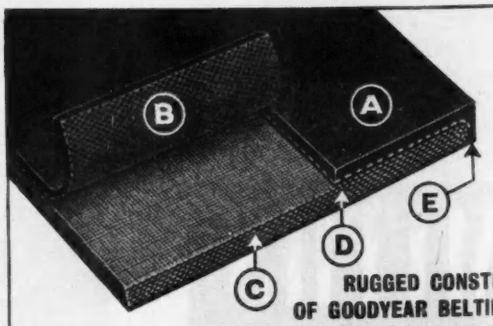

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ENGINEERING

An Illustrated Weekly Journal

Vol. 181 No. 4703

APRIL 27, 1956

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LAND, SEA AND AIR RECORDS

BRITAIN holds the world speed records for land, sea and air. The late John Cobb reached 394·2 m.p.h. as long ago as September, 1947; Mr. Donald Campbell achieved 216·2 m.p.h. with Bluebird last November; Mr. Peter Twiss piloted a Fairey Delta 2 at 1,132 m.p.h. on March 10. This triple crown for speed is the best possible evidence that Britain is still in the front rank of engineering development, whether it is development on the grand scale, with liberal financial support—as with high-speed aircraft—or development on a shoe-string, made possible by sheer hard work, ingenuity and enthusiasm. As other nations are likely to try and wrest the honour from us, it is worth reviewing, very briefly, the prospects for further advances in the future.

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Of the three records, that on water is probably the one which could most easily be pushed up, given the time and money. It would, however, require much more financial backing than has been provided in recent years. There is no dominant commercial interest in reaching high speeds on water; if there were, the record would undoubtedly stand much higher to-day than it does. The Union of International Motor Boating, unlike the equivalent authority for land speed records, have no objection to jet propulsion, but they forbid a boat which would be virtually airborne and they forbid the use of air or water elevators, flaps, etc. High-speed craft run into natural frequencies of oscillation of many cycles per second, and it is probable that the structural problems arising out of this difficulty will have to be solved by developing a suspension system which would insulate the hull of the craft from the oscillations of the floats. The success of the Bluebird last year was due, very largely, to the application of the structural techniques of aircraft design. It was also due to the enthusiasm of a handful of people who, if given one-tenth of the backing which is accepted as normal for aircraft work, could certainly achieve some remarkable results within a few years.

High speed on the motor race track is of widespread interest. It is therefore surprising that no one has improved on the land speed record, which has held for 8½ years. It may be that some of the interest in the record is diminished by the knowledge that higher speeds can be attained and have, in fact, already been attained by jet propulsion of a wheeled vehicle. Yet the prestige value of a record is considerable, even if the experience of designing and building a motor-car to travel at 400 m.p.h. is of doubtful significance to an industry whose bread and butter depend on cheap family cars. But even supposing a determined attempt were to be made to put up the record, in conformity with international rules, it is doubtful whether very much higher speeds could be attained.

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The air speed record, however, presents a different prospect. Having entered the realm of supersonic speed, aircraft and jet-engine designers can see no reason to forecast an ultimate limit, though they can see plenty of extremely complex and difficult problems ahead of them. If we exclude rocket-powered aircraft, one of which, of course, had previously flown at a speed higher than the Delta 2 record, we are faced primarily with the complications arising out of friction-generated heat at high speeds in the atmosphere. As regards airframes, the next generation of high-speed aircraft will almost certainly be using steel—or possibly titanium alloys—as the main structural material in place of aluminium alloy, because of their better thermal strength properties. As speeds go up, more complex refrigeration will be required to keep the pilot and some equipments cool. Great care will therefore have to be taken in integrating the design of the aircraft, its power plant and equipment in order to keep the total weight down. The possibility of designing piloted aircraft, powered by turbo-jet, for speeds up to Mach 3 is accepted. But above this speed cooling problems require such complication of equipment and additional weight that the pilot may have to be considered an expensive luxury.

As regards turbo-jet engines, increased turbine inlet temperatures are already envisaged as a result of air-cooled blade developments at the National Gas Turbine Establishment, which will enable slightly higher thrusts to be attained at substantially lower fuel consumptions. Mach 3, for short periods, should then be a practical proposition from the power-unit point of view. Already, with existing turbine inlet temperatures, afterburning can produce sufficient thrust for speeds well over Mach 2·5, but with a very heavy penalty in fuel consumption.

Only in the air does the speed record continue to be of immediate practical interest. On land even the most modern roads are inadequate, and all but a few drivers are unequal to driving at high speeds. On water the running costs of high speed would be far too high to be of practical value, and unfortunately sea-water is not always smooth. In the air alone, there seems to be no limit to man's ambition or ability.

Plain Words

Mr. Harold Watkinson, Minister of Transport and Civil Aviation, has several objectives for the British Overseas Airways Corporation. He intends to pursue them vigorously, relentlessly and without interference ("there is a ready course open to anyone who disagrees"). He spoke of his plans as "large and ambitious" and as fitted to succeed in "the highly competitive days ahead."

These are brave words indeed on the part of anyone in the very responsible position Mr. Watkinson holds. But what are these plans?

(1) New ideas, new men, new brains—starting with the appointment of Mr. Gerard d'Erlanger as part-time chairman and Sir George Cribbett as full-time deputy chairman. The exit of Lord Burghley (for ten years a member of the part-time Board) and the resignation of Lord Rennell, the part-time chairman.

(2) An all-British air fleet, consisting mainly of Britannias and Comets.

(3) Closer co-operation between B.O.A.C. and the shipping lines.

(4) Policy to be a matter between the Minister and the chairman.

Outwardly, the Minister's action was triggered off by the resignation of the Corporation's chairman, Sir Miles Thomas, after eight years in office. The implications of Mr. Watkinson's objectives—most of which are in fact a complete reversal of Sir Miles's policy—are that the Minister disagreed fundamentally with the chairman, and that their disagreement played a major part in the latter's resignation.

The manner in which the changes were announced confirms this impression. They were discussed with the Prime Minister, but not with the retiring chairman or with the B.O.A.C. Board. Lord Rennell, the deputy-chairman—a man of the highest standing in the City of London—was told of the new appointments the day before they were made, and promptly resigned. Shortly after the resignation of Sir Miles Thomas, a deputation headed by Lord Rennell saw the Minister to attempt to persuade him to fill the vacancy from within, so as to preserve stability and continuity in the Corporation's affairs. A member of this deputation, Lord Burghley (chairman of B.O.A.C.'s Technical Comittee) is reported to have been very forthright in stating his views. He was subsequently informed by the Minister that his membership of the part-time Board would not be renewed. All this adds up to a strong reaction from the policy and personal attitudes of the retiring chairman. If so, it is unfortunate since such reactions generally tend to result in introducing a subjective element in policy making which is not often conducive to sound decisions.

The main issue, as we see it, is the strong personal claim to control asserted by the Minister. How can anyone inside the Corporation be forthright in stating his views when he is aware of the result of a clash with Mr. Watkinson? And how can B.O.A.C. be loaded fairly and squarely with the responsibility for its balance sheet if it is to be hamstrung by decisions imposed by a Government department? The statement that the Corporation must co-operate more closely with the shipping lines, with which it competes, is hardly calculated to inspire confidence—particularly in view of the associations that exist between them and private air operators.

Few will quarrel with the appointment of the new chairman. Mr. d'Erlanger served on the boards of British air-lines from 1935 to 1946, when he founded British European Airways. He is a recognised authority in the world of civil aviation and finance. Sir George Cribbett, who was a deputy secretary in Mr. Watkinson's Ministry, is a less obvious choice but is familiar with the problems he will encounter. Both have been pilots, and Mr. Watkinson wants to raise the status of pilots. But will he raise the status of B.O.A.C.?

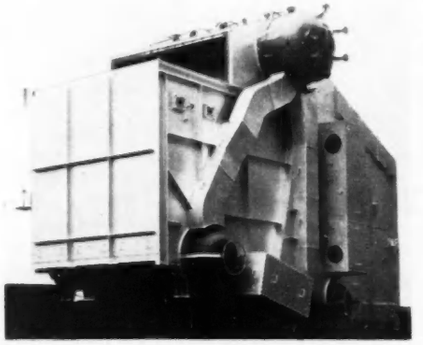
"EMPRESS OF BRITAIN"

Few ships are built to a common pattern and the maiden voyage of a new liner is always a unique event. The "Empress of Britain" is exceptional less by virtue of her elegant lines than in the unusual character of her propulsion machinery, and one of her most novel features is the use of a reheat steam cycle. Built by the Fairfield Shipbuilding and Engineering Company, Limited, of Glasgow, and operated by the Canadian Pacific S.eamship Company, she is the third vessel to bear her name and has a gross tonnage of 26,000 tons; the displacement of her predecessor was 42,350 tons. The ship is 640 ft. in length, 85 ft. beam and 48 ft. in depth with a draught of 29 ft., and has a service speed of 21 knots. She is designed to carry a total of 1,050 passengers and has a crew complement of 465. Apart from the reheat cycle, other noteworthy features are the tandem arrangement of the high-pressure and intermediate-pressure turbines, the "fireman's helmet" funnel and overall air conditioning by Thermotank Limited.

Hull and Superstructure

Although at first sight the Empress of Britain seems to be of orthodox general appearance, it will be noticed that the modern tendency to produce a piled-up superstructure has been largely avoided, and she is believed to have a lower silhouette than any other new vessel of comparable size. The structural design involves a combination of longitudinal and transverse framing and makes extensive use of welding. In addition the keel, sheerstrake and two strakes of plating about the waterline are of special welding-quality steel, and the scantlings of the frames and shell forward have been increased for ice stiffening. All butts are welded and there are only four riveted seams on each side. Frames in all cases are riveted.

The machinery consists of a twin-screw double-reduction geared turbine installation operating on the Fairfield reheat system of propulsion for high thermal efficiency. The main pro[illegible]ng units are of Pametrada design and each consists of a high-pressure ahead impulse turbine in tandem with an intermediate-pressure ahead turbine, also of impulse design, driving a primary pinion, and a low-pressure double-flow reaction turbine driving a separate primary pinion. The steam after passing through the H.P. turbine is reheated to its initial temperature before entering the I.P. turbine.



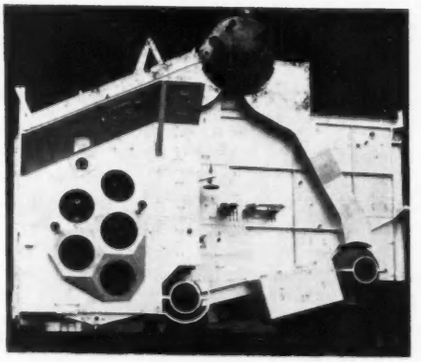


Fig. 1 Two views of reheat boiler prior to installation in "Empress of Britain." It is arranged to generate and supply superheated steam to the main range when the ship is steaming at moderate or full power.

Main and Reheat Boilers

The boiler installation comprises two Foster Wheeler type controlled superheat boilers and one reheat boiler (Fig. 1), each designed for a pressure of 680 lb. per sq. in. and a temperature of 850 deg. F. The reheat boiler is arranged for the generation and supply of superheated steam to the main range when the ship is steaming ahead at moderate or full power and is provided with two separate reheating units receiving steam at about 650 deg. F. from the port and starboard H.P. turbine exhausts, and returning it to the I.P. turbine inlets at 850 deg. F. At lower powers, reduction in steam pressure at either of the H.P. turbine exhausts results in the closing of one of the two valves arranged in series in the oil-fuel line to the reheat boiler, thus shutting down the unit and excluding the possibility of overheating the reheating elements. Likewise, for astern running, the reheat boiler cannot be operated. The reheat circuit is indicated in Fig. 5 and the arrangement of the main steam system can be seen in Fig. 4.

The Foster Wheeler controlled superheat boilers are of two-furnace design, each furnace having one small and four large burners designed to operate at 400 lb. per sq. in. The reheat boiler is of single-furnace pattern with the reheating elements located between the superheater and low-temperature generating tubes, thereby protecting the elements from furnace radiation when the boiler is shut down. One small and four large burners are fitted to the furnace, the small one being used for warming the boiler when the reheating elements are not being circulated. Each boiler is fitted with an economiser and a bled-steam air heater and is arranged for burning oil fuel with balanced draught.

At service power the controlled superheat boilers each supply about 60,000 lb. per hour of superheated steam and 7,000 lb. per hour of saturated steam, while the reheat boiler supplies about 50,000 lb. per hour of superheated steam in addition to reheating the steam from the H.P. turbine exhausts. Steam drums are of fusion-welded steel with welded ends, and water drums comprise solid-drawn tubes of uniform thickness with integral ends. The internal diameter of the steam drums for the controlled superheat and reheat boilers are 4 ft. 10 in. and 4 ft. 2 in. respectively. Boiler-tube work has been carried out by John Thompson Limited, of Ettingshall, Wolverhampton.

Turbines

The H.P. and I.P. turbines are of the multi-stage impulse design, having 9 and 12 single-row wheels respectively. The L.P. ahead turbines are of double-flow reaction type with 15 stages per flow. At service power the H.P. and I.P. turbines run at 4,195 r.p.m. and the L.P. turbines at 3,450 r.p.m. corresponding to a propeller speed of 123 r.p.m. For astern working each set of machinery incorporates an H.P. astern turbine overhung from the forward end of the I.P. turbine and an L.P. astern turbine, consisting of one two-row impulse wheel followed by one single-row impulse wheel, located in the L.P. ahead casing. The H.P. and I.P. ahead and H.P. astern cylinders are of cast steel with ½ per cent. molybdenum content, the L.P. cylinders and astern nozzle boxes of cast steel, and the L.P. casings of fabricated steel. All impulse blading is of stainless iron, with the blades carried on inverted T-root fixings. The dia-

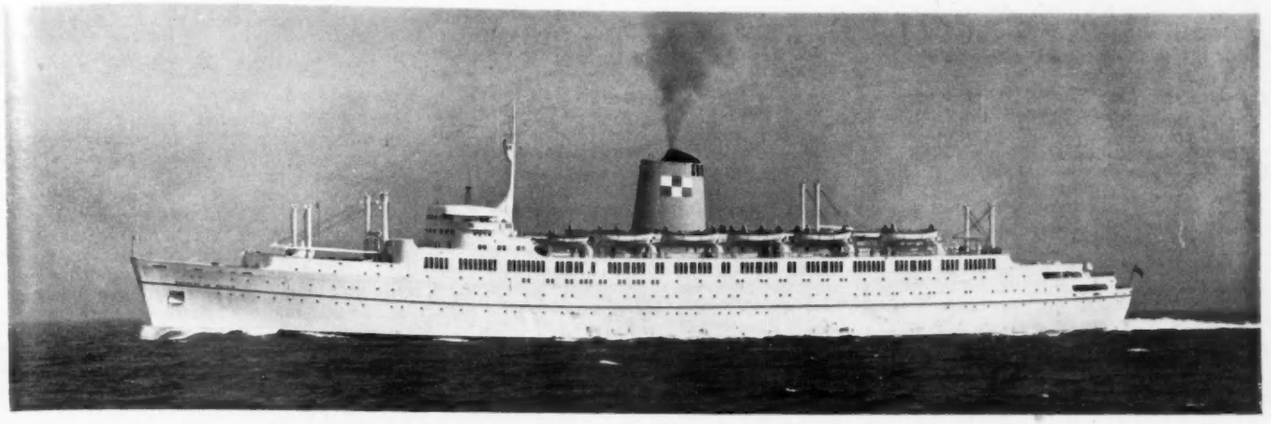


Fig. 2 The " Empress of Britain ", launched by H.M. The Queen, is believed to have a lower silhouette than any other new vessel of comparable size; a piled-up superstructure has been avoided.

phragms are constructed from rolled strip and packer sections. The L.P. reaction blading is of the side-locked segmental type with the exception of the last four rows at each end of the rotor; these have integral roots. The turbine bearings are of up-to-date design with a L/D ratio of 0·5 to 0·67 and with the centre portion of the top halves chambered to a depth of 0·032 n.

The main condensers are of Weir two-flow regenerative pattern, each having a cooling surface of 14,000 sq. ft. with ¾ in. external diameter 70/30 cupro-nickel tubes.

Gearing

The gearing is of the double-reduction, double-helical semi-articulated type, the primary gears having a 5/10 in.—16 deg. tooth form and the secondary gears 6/10 in.—16 deg. tooth form. Each primary and main wheel has a cast-iron centre mounted in a tapered spindle and provided with shrunk-on forged nickel-steel rims of 40 tons per sq. in. tensile strength. The gearcase is of fabricated steel construction fitted with bearings having an L/D ratio of 0·67. Pinions are made of oil-hardened nickel chrome and molybdenum steel with a tensile strength of 55 tons per sq. in.

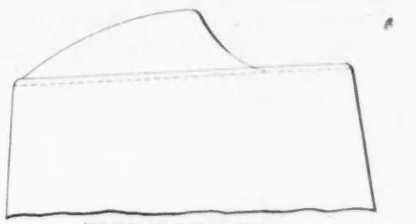
After hobbing, the gears were selectively shaved* so as to ensure full meshing contact over each helix, and silence in operation. The turning gear for the main engines drives through the aft end of the H.P. primary pinion and an interlock is provided on the manoeuvring handwheel so that it cannot be operated while the turning gear is engaged.

The propellers are four bladed and 18 ft. in diameter, the working propellers being made from " Novoston " and the spare propellers from manganese bronze. The propellers were designed and manufactured by J. Stone and Company, Limited.

Funnel

The streamlined funnel is largely of aluminium construction. As indicated in Fig. 3, the main and auxiliary boiler soot arrestors are situated in the funnel and the uptakes from the arrestors terminate in nozzles designed to give an outlet gas velocity of about 120 ft. per sec. at 90 per cent. full power; bypass ducts are provided for use at maximum power and are controlled by dampers operated pneumatically from the firing platform. The funnel is 51 ft. high and the final 6 ft. take the form of a " fireman's helmet," which, with the high gas speed, carries the smoke clear of the decks under all normal wind conditions, as may be gathered from Fig. 2.

* See ENGINEERING, January 27, page 107, 1956.



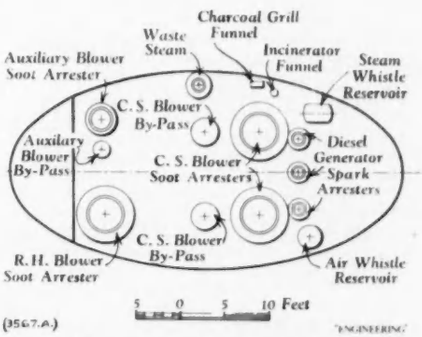
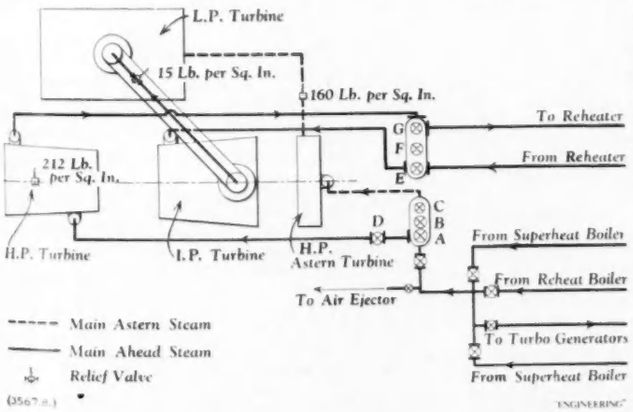


Fig. 3 Plan and profile of funnel. The " fireman's helmet " form has been chosen to carry smoke clear of the decks.

Closed Feed System

The main feed system comprises four extraction pumps (two working and two standby), two



—	Manoeuvring valves		Astern shut off valve	Ahead emergency valve	Reheater bypass valves		
	Ahead	Astern					
	A	B	C	D	E	F	G
Normal ahead running	Open	Shut	Shut	Open	Open	Shut	Open
Manoeuvring	Open or shut	Open or shut	Open	Open	Shut	Open	Shut
Astern running	Shut	Open	Open	Open	Shut	Open	Shut
Ahead running (without reheat)	Open	Shut	Shut	Open	Shut	Open	Shut

Fig. 4 Main steam system showing tandem arrangement of H.P. and I.P. turbines.

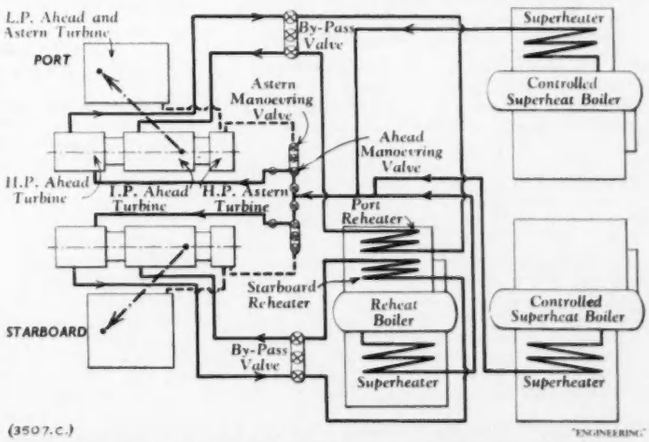


Fig. 5 Arrangement of Fairfield reheat system. The reheat boiler (Fig. 1) has two separate reheating units which receive steam at about 650 deg. F. from the H.P. turbine exhausts and returns it to the I.P. turbine inlets at 850 deg. F.

air ejectors, two gland ejector condensers, one drain cooler, one turbo-reciprocating feed pump (working), two standby turbo-feed pumps, one condensate circulated distiller and one feed heater. Bled steam for the feed heater and air ejector is taken from the outlet of the 10th stage of the I.P. turbines. The drains from the feed heater are led to the main drain cooler flash chamber. A single-stage twin-element air ejector is fitted to maintain a vacuum in the drain cooler.

A Weir steam-to-steam generator is installed to supply steam at 125 lb. per sq. in. gauge for oil-fuel heating, galley, gland steam and make-up feed. The generator is capable of an output of 10,000 to 12,000 lb. per hour when supplied with saturated steam at 680 lb. per sq. in. pressure from the controlled superheat boiler steam drums. The generator is fitted with a drain cooler, the drains from which pass to the main drain cooler flash chamber.

Auxiliary Boiler

The Howden-Johnson type auxiliary boiler is 15 ft. in inside diameter, 7 ft. between tube plates and has a heating surface of 2,500 sq. ft. It is capable of evaporating about 15,000 lb. of saturated steam per hour at a pressure of 200 lb. per sq. in. The auxiliary boiler is primarily for port use.

Evaporating Plant

A single-effect evaporating plant made by G. and J. Weir, Limited, is fitted and is capable of producing 130 tons of distilled water every 24 hours from sea water, when supplied with steam from the auxiliary steam range at 125 lb. per sq. in. gauge, or bled steam from the I.P. turbines. The plant consists of the following units: a 935 sq. ft. cast-iron evaporator, a 900 sq. ft. distilling condenser, a single-stage air ejector, a fresh-water extraction pump, a brine pump, an evaporator feed pump, and condensate circulated distiller. When operating on bled steam the evaporator-coil drains are led to the main drain cooler flash chamber and when operating on auxiliary steam they are led to the auxiliary drain cooler flash chamber. The sea-water supply to the evaporator is treated with ferric chloride to prevent the formation of scale on either the heating surfaces or the shell of the evaporator.

Steering Gear and Stabilisers

The steering gear has been made by Brown Brothers, Limited, and is of four-ram pattern. It has two power units each consisting of a variable delivery pump coupled to a 45 horse-power motor. With one power unit in use the gear is capable of moving the rudder from hard-over to hard-over (70 deg.) in 45 seconds, with the vessel moving at full speed ahead, or in 25 seconds with both power units operating. Ease of manoeuvring is an essential, since the ship will be required to negotiate the St. Lawrence waterway regularly. Denny-Brown stabilisers are fitted.

The Empress of Britain was due to arrive in Montreal yesterday after setting out from Liverpool on her maiden voyage on April 20.

Letters to the Editor

WELL-DEVELOPED COUNTRY

SIR, The engineers in our department enjoyed the title "Engineering Projects in Undeveloped Countries," which was over a short squib on the Tennessee Valley Authority (November 4, 1955, page 621).

Really, Mr. Editor, you would be surprised, most of us wear shoes and clothing, and have no feathers in our hair.

Very truly yours,
SAMUEL A. EVANS.

4936 Palm Drive,
La Canada, California,
U.S.A.
April 6, 1956.

[*Editor's note:* The title (Engineering Projects in Undeveloped Countries) referred to a previous article; the sub-title (Capacity of Tennessee Valley Authority) to the letter it was placed over. We apologise for the near-slanderous conjunction of title and sub-title.]

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TESTING CONCRETE QUICKLY

SIR, We are pleased to note from Professor J. W. H. King's letter of March 19, 1956, published in your issue of April 6, that he found our article "Accelerated Curing of Concrete Test Cubes" to be of interest. We note that Professor King writes of, and his letter is headed, "Limitations of the Steam Bath." Thus far, of course, this does not discuss our method, which is concerned with the curing of cubes in boiling water.

We do not agree with the objections raised by Professor King against our method. For example, we have shown that the cubes are still gaining strength at 16½ hours and in this both Professor King and ourselves are in agreement. Secondly, we have experienced no troubles with corrosion of the cube moulds either with the boiling-water method or with the oven method of curing.

We cannot understand Professor King's reference to the alteration, by the method of curing, of the ratio of water to cement. We can understand that it may be thought that water curing may erode the surface of the cube before the concrete has hardened, but this does not happen. With fully compacted cubes, which should of course always be the case, alteration of the ratio of water to cement can mean only the alteration of the voids ratio by a volume increase before the cement is set. This, of course, does not happen.

Our method had its initial development in the laboratory and we are just as averse as is Professor King to large amounts of steam in the laboratory, but with the lid kept on the boiling-water containers this does not happen.

We have, of course, had the advantage of being able to compare our method with that advocated by Professor King and we consider it to be simpler, cheaper and just as reliable. We shall be only too pleased to co-operate with him in the development of the cheapest and most reliable accelerated curing test.

Yours faithfully,
T. N. W. AKROYD,
R. G. SMITH-GANDER.

John Mowlem & Co., Ltd.,
Concrete Laboratory,
65A, Old Church-street,
London, S.W.3.
April 16, 1956.

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LOCOMOTIVES FOR BRITISH RAILWAYS

SIR, In your article entitled "Locomotives and Rolling Stock" (April 13, page 204) you state "all the eleven locomotives to be built by the North British Locomotive Company for the B.T.C. will have German M.A.N. engines and Voith transmissions."

In point of fact only the first two locomotives will have German M.A.N. engines and Voith transmissions because the remaining M.A.N. engines and Voith transmissions will be manufactured in our works in Glasgow.

Yours faithfully,
North British Locomotive Company, Ltd.,
T. A. CROWE,
Chairman and Chief Managing Director.
April 18, 1956.

D.S.I.R. AND THE B.I.F.

Change in Policy

For many years the Department of Scientific and Industrial Research has been among the exhibitors at the British Industries Fair, but the equipment and apparatus shown has been anonymous in the sense that the names of their producers have not been attached to any proprietary product. This policy is now rightly considered to be out of date and, as the object of the Department is to encourage the use of science in industry, it is only logical that what is already being done in this direction should receive due notice. This year, therefore, the exhibits on the stand of the Department at Castle Bromwich are demonstrating the application of research to the development of industrial products in a number of fields. None of these exhibits has, in fact, originated from the Department's laboratories, but they have been selected from 200 competitors, care being taken in choosing the score or so of displays to show the variety of ways in which science and industry are co-operating.

ENGINEERING EXHIBITS

Among the exhibits of engineering interest mention may be made of a metering pump, manufactured by Ormerod Engineers, Limited, Rochdale, which will add measured quantities of liquid, particularly a hot, viscous liquid, to a process. It is actually being used in the textile industry to control the percentage of size put into a warp, but, of course, has other applications. Steele and Cowlishaw, Limited, Hanley, Stoke-on-Trent, are showing a high-speed ball mill for grinding not only paints, for which it was designed, but metal powders such as those used in permanent magnets. It is claimed to give a better product much more quickly than one of the orthodox type and is put forward as an example of research based on a combination of experience and experimentation. The main feature of the grinding spindle exhibited by Reilly Engineering, Limited, Pilot Works, Guildford, is the combined hydraulic journal and thrust bearing. Speeds of 148,000 r.p.m. have been obtained with this device.

A HYDRAULIC TRACTOR

The National Institute of Agricultural Engineering, Silsoe, Bedfordshire, is showing the test rig of a tractor with hydraulic transmission. It is, in fact, the only exhibit on the stand which is not in production. It is modelled on existing agricultural tractors, but much development work remains to be done by manufacturers.

Nylon is treated as an engineering material by the British Rawhide Belting Company, Limited, 246 Great Portland-street, London, W.1, who are exhibiting a conveyor made of this material. The belt is light in weight, quiet in action, resistant to acids and alkalis, has a low coefficient of friction and is easily cleaned. The production of this conveyor is the result of considerable research which is still continuing. Leicester Lovell and Company, Limited, Southampton, are showing press tools made from an epoxide resin. This material has, it is found, a long life, and punches made of it have shown no appreciable wear after 27,000 pressings, whereas high-carbon steel punches failed after about 20,000 of such operations.

The metallurgical industry is well represented. A new manufacturing process, which has cut the cost of producing titanium powder and was the subject of an article in last week's issue, is being shown by Imperial Chemical Industries, Limited, Liverpool; also being exhibited is a new method of casting the same metal by William Jessop and Company, Limited, Sheffield. A process of casting steel, which should greatly reduce wastage, is being exhibited by Campbell, Gifford and Morton, Limited, Weybridge, and a method of obtaining hardened anodised surfaces for aluminium is displayed on behalf of Hard Aluminium Surfaces, Limited, Glasgow.

Weekly Survey

Cover Picture: *Without machine tools, industry would still be in the hammer and chisel stage and many of the engineering products which are to-day familiar and accepted features of our lives would never have come into being. A further advance may be heralded by the Machine Tool Exhibition to be held at Olympia in two months time. The illustration shows the machining of side facing joints for a turbine inlet casing.*

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What the Russians Want

The kinds of goods in demand in the Soviet Union during the next decade can be predicted with reasonable accuracy on the basis of the main trends of that country's political and economic development. First, there is a chronic shortage of manpower, particularly of skilled operatives in manufacturing industries. Second, the Soviet Government's desire, born perhaps of political necessity and the factor of a fast growing population, to increase food supplies and to provide more and a greater variety of consumer goods. Third, the urgent need to improve transport facilities, not only within the Soviet Union but throughout Soviet eastern Europe, where their inadequacy is the main obstacle to a rapid growth in trade in what has become the most closely integrated "one-market" area outside America.

Soviet Russia can therefore be expected to import plant and machinery for food production and processing, specialised agricultural machinery, flour milling plant, confectionery machinery, food-canning plant and packaging machinery. It will also require a great deal of raw material processing plant and a wide range of metallurgical equipment, particularly large capacity integrated rolling mills and alloy-steel making plant, including electric melting furnaces. Chemical plant and plant for synthetic fibre manufacture can also be included under this heading. There is inadequate local production of large prime movers: large capacity thermal electricity generating plant, large electric motors, electricity distribution equipment and Diesel engines are likely to be wanted. In the manufacturing industry there is an urgent need for more special purpose high-speed tools of all types, with ancillary electronic control instruments. Electronic computers and mechanical handling plant suitable for automatic factories will receive a high priority. Certain types of textile machines, particularly winding and knitting machines, are in great shortage and already constitute a substantial proportion of British exports to the Soviet Union. The country's need for a rapid expansion of transport systems will call for road-making plant, a wide range of heavy earth-moving equipment, as well as heavy road transport vehicles, delivery vans and ocean-going ships.

This is by no means an exhaustive list but it reflects the inquiries made in recent months in East Berlin, Leipzig, Geneva and elsewhere. Few developments of importance can take place until the embargo list, published by the Board of Trade in October last year, is substantially shortened since most of the products in which interest has been expressed figure prominently on the list.

Among the British firms who have been endeavouring to expand their trade with Soviet eastern Europe in the past two years are Metropolitan-Vickers and other A.E.I. companies, British Insulated Callender's Cables, Broom and Wade, the Brush Group, Crompton Parkinson, F. Perkins, Rolls-Royce, Standard Motors, and Textile Machinery Makers.

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Factory Building Trend

There is evidence of a large drop in the amount of new industrial building approved in the first quarter of 1956 compared with the same quarter a year ago. Seven industrial regions (these include London and the South East, West Midlands, North Midlands, Lancashire, Yorkshire, Wales and the West Country) have reported an average decline of about 20 per cent. between these two periods. A few of the returns cover manufacturing industry only, but the sample is certainly large enough to be indicative of a trend. On the other hand the rate at which constructional work is being started, having been approved some months ago, is running at a high level and the high rate of approvals of new buildings recorded in 1955 is likely to ensure that 1956 will be a very busy year in constructional engineering.

In most of these regions there are signs that the credit restrictions have caused the postponement of expansion plans for new factories for domestic appliances, television sets and vehicle components. It is therefore almost certain that a very high proportion of the certificates requested are for expansion plans in general and electrical engineering and metal fabrication. In the West Midlands the vehicle industry, which last year took a quarter of the total floor space approved, has severely reduced its demands and so have a number of consumer goods industries. The North Midlands area, where the hosiery and footwear industries are well established, seems to have been affected by the squeeze more than might be expected, and it is noticeable that in Wales, where expansion of light industries has been particularly marked of recent years, there has also been a significant drop in new space approved.

There is here a most awkward problem of timing. There was a good deal of criticism towards the end of last year that the level of new factory space approved was running at far too high a level for the available supply of men and materials to build them. There are now definite signs that the pressure of demand is easing off, but this will not be felt on the resources of the building and constructional engineering industries until 1957. The level of activity in 1956 will be exceedingly high at a time when pressure is being exerted on many industries to switch their goods into the export market or cut their production.

There is thus some danger that the adjustment of the economy to general economic conditions may be complicated by the fact that some industries are expanding or contracting at the wrong time. This is one of the consequences of tackling inflation by bringing pressure to bear on the public's spending habits and the overdraft facilities of companies. If, as some critics have argued, one of the main causes of the increased inflationary pressure in 1955 was the high volume of factory space approved and started, the country is going to feel the consequences in 1956 and 1957. In 1956, it will be difficult to make the policy of deflation work quickly enough and in 1957 it will be correspondingly difficult to offset it by other measures.

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The Professions and the Budget

As many people expected, the Chancellor of the Exchequer made the need for saving the main theme of his Budget this year. No one will quarrel with his efforts to stimulate thrift in the public at large. He has been right to try to find a novel way of appealing to people to save money, for it is a subject on which the great majority are apathetic. A combination of a depreciation in the value of money and the concentration of purchasing power in classes of the community who, through no fault of their own, have no tradition of thrift, makes it necessary for Mr. Macmillan to make a quick imaginative impact on the electorate as a whole. There is to be a new version of the Dodo's caucus race. Everybody can run and a few will get prizes, but no-one will lose.

Those who had expected a "middle class" budget have had to be content with proposals for tax-free retirement pensions for self-employed persons, controlling directors and others not at present in pensionable employment. There has been no modification of the surtax rate but there has been an increase in the profits tax on both distributed and undistributed profits. If the Chancellor's concession on pensions for the self-employed could be confidently interpreted as the thin end of the wedge, there might be some grounds for optimism. The fact is, however, that as the present Government gets nearer to the date of the next General Election the likelihood of any concessions to those in the middle and upper income brackets becomes increasingly slight. The plight of those in professional work, among whom are a significant number of engineers, is not made much better by this year's Budget. There is still no incentive for the older and higher paid members of the professions to work any harder, and every incentive for the younger members of the profession to go into salaried employment. From this point of view the Budget is an incentive to save but not an incentive to work harder.

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The Budget on the Outlook

Of all the concessions, tax impositions and forecasts which the engineering industry, like many others, might have liked to see in the Budget, the one which seemed most likely to come out on Budget day was some idea of the duration of deflation. It was hoped that the Chancellor would say something about the target which he would set for the contraction of certain industries and for the movement of labour from one industry to another in order to achieve success in the fight against rising prices.

There was some hope, too, that the construction of the Budget proposals themselves might give an indication of whether the Chancellor thought that the policy of deflation had gone far enough or not. In the event Mr. Macmillan gave nothing away. It is clear from his Budget speech that the Government have not yet made up their minds how much further deflation ought to go. The structure of the Budget itself is cautious. The Chancellor has budgeted for a large surplus, which means that he will force the community to save involuntarily. He has taken the view that it is better to press on with deflationary tactics and change over at fairly short notice to another tack than to ease the deflationary pressure on the economy now, only to have to impose it again some time later this year. It is a cautious policy but few in the same position would have done differently.

One feature in the Budget is important so far as ordering equipment from the engineering industry is concerned. The decision to make the nationalised industries raise their capital by means of a subvention on the nation's capital account (and £350 million has been allocated for this purpose in this year's "below the line" or capital account) has been made with the idea of lessening the irregular, and at times disturbing, influence of the nationalised industries on the open capital market. It is also aimed at increasing the speed and flexibility of the Government's control of the investment policy of these industries. This could mean that in future the flow of orders from the coal, electricity, gas and transport industries could be turned off or on fairly abruptly. Some sections of the engineering industry have already suffered from the abrupt changes in the policy of nationalised industries, and the engineering industry as a whole is now duly warned that if in the Government's opinion the rapid expansion or contraction of these industries is required in order to bring about a certain effect on the economy as a whole, the buying policy from these major users of engineering equipment may change suddenly.

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Heating in British Homes

Britain's wonderfully temperate climate provides her citizens with a choice of fuels and appliances unmatched anywhere else in the world. This, and the traditional cheapness and ready avail-

Practising control of a Bentley on an oil-covered " skid pan " (see " From Safety to Skill ").

ability of solid fuels, go far to explain why the main space-heating system in use is the open fire. An article in this issue by Mr. W. F. B. Shaw, who is the Chief Physicist at the Fuel Research Station, reviews in some detail the developments that have taken place in recent years in the techniques of space heating, water heating and the provision of cooking facilities. He also compares the cost of various methods of space heating, and reviews within broad groups the very wide range of appliances available.

Mr. Shaw explains that in a less temperate climate the open fire is ruled out on account of " the inordinate amount of cold air which it draws through the house." It is perhaps significant, however, that most visitors to our shores from the coldest countries, say that only in Britain have they experienced real cold. Yet more fuel is probably wasted and more smoke generated per useful therm produced than in any other country. Homes heated throughout at an even and controlled temperature are a rarity and, in the opinion of many, an unnecessary luxury. They point out that radiant heaters in separate rooms, i.e., fires which have " a focal point of comfort," are exceedingly flexible and therefore most appropriate to the needs of a family in this country. They can be lit or let out when required.

The past few years have seen a change. The rising price of coal, and of the fuels derived from it, is driving home the need to economise and also giving oil an opportunity to replace solid fuel. The old-fashioned open coal fire is being replaced by openable stoves or convector open fires; central heating is gaining ground very slowly and paraffin stoves are in great demand.

Mr. Shaw's statistics show that electricity and oil had, by 1952, made a relatively very small impact; main space heating was by solid fuel in 98 per cent. of all homes; electricity predominated only for ancillary heating, which was present in only 15 per cent. of homes. Gas and solid fuel accounted, approximately equally, for 91 per cent. of water heating in the winter and 86 per cent. in the summer; the balance was electric in each case. Cooking was 72 per cent. gas, 15 per cent. solid fuel, and 14 per cent. electricity. These figures are thought to be practically unchanged to-day, except that the statistics of the sale of oil-burning appliances suggest that this method of heating has made very large gains in the past year. In the main this has been through the introduction of portable kerosine-burning space heaters (blue-flame heaters) for which the demand has been so great that the supply from manufacturers has been most inadequate. Output of blue-flame heaters last year is estimated at about 1·2 million units; demand is thought to be about 2 million units a year. The oil companies, which are vitally interested, believe that the rising prices of coal and fuels derived from coal will hasten the progress of the blue-flame heater as well, of course, as of the oil-burning boiler. The latter has been held back by the shortage of suitable, reasonably priced burners.

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From Safety to Skill

" Safety " has been the catchword in official endeavours to reduce road accidents. But anyone who takes an interest in the driving of motor-cars knows that safety should be no more than a by-product—however important—of skilful driving. The present-day rise in the standard of skill will go a long way towards making the most of inadequate roads, and it will increase the efficiency of what might be called the mechanical handling of passengers and goods.

Latent interest in skilful driving is shown by the fact that the Buckinghamshire Constabulary have difficulty in satisfying all demands for places on the motorists' refresher courses which they run. These courses are designed to assist motorists who wish to improve their standard of driving. A series of talks and discussions, and a visit to the police wireless control room, culminates in a visit to the " skid pan," where the motorist acquires familiarity with skidding and the skill in getting out of it. The old concrete base of an aircraft hangar is covered with a wide ring of used engine oil, on which the driver is soon able to induce a skid through 180 deg. The sides of the car are horribly splashed, but that is overlooked in the surge of confidence which comes as he finds that correcting a skid can become second nature to him.

Two admirable books on driving which have recently appeared confirm the trend away from safety as the only worth-while aim. *Road Craft* is a manual of driving instruction for students of the Motor Car Wings of the Metropolitan Police Driving School, which is now available to the public (H.M. Stationery Office, 3*s*. 6*d*.). It covers the subject in the manner of a military instruction manual, but is none the worse for that. Some of the diagrams are particularly helpful on the finer points of driving. *The Skilful Driver* (Temple Press, 10*s*. 6*d*.) will interest readers of ENGINEERING because it is by Dr. J. S. Blair, a director of engineering research whose writings on the strength of tubes and allied subjects have appeared in these columns. His attitude of mind to the skill of driving is characteristic of a man of his scientific experience and position, and it is an attitude which, within the next generation, should become the accepted practice.

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Convair Developments

Two important announcements have been made recently by the Convair Division of the General Dynamics Corporation, San Diego, California, U.S.A. They are to enter the jet air-liner field and they have been awarded a contract by the United States Air Force to develop an airframe for a nuclear-powered aircraft.

Convair have for some time been working on the first U.S. Air Force contract for research and development leading to the design of such an airframe, and for many months have been flight-testing a B.36 bomber aircraft equipped with a Convair-built atomic reactor. The latter does not power the aircraft, but is activated in flight to study shielding problems and radiation effects on the aircraft, and to develop airborne nuclear instrumentation.

The new projected air-liner by Convair will be known as the Skylark 600, and is intended for medium-range operation at a cruising speed of 609 m.p.h. Deliveries are expected for early 1960. In appearance it will follow the current American trend with swept-back wings and tail surfaces and four podded engines—General Electric CJ-805 turbojets, the commercial version of the J.79 engine, which is claimed to have the highest thrust-to-weight ratio of any engine in the same thrust category. What thrust is developed has not been released, but it is believed to be well into the " 10,000 lb.-plus " range.

The Skylark has been designed for a maximum take-off weight of 170,000 lb. In the first-class version, 80 passengers will be carried, and in the tourist version 99 passengers can be seated in five-abreast seating. The aircraft, it is claimed, will be suitable for stage distances from 300 to 2,000 miles; but whether it can be economically operated at the shorter ranges is perhaps open to doubt. It will be capable of operating from 5,000 ft. runways.

The dimensions of the new aircraft as planned at present are as follow: wing area, 2,000 sq. ft.; wing sweep, 35 deg.; span, 118 ft. 4 in.; length, 118 ft. 5 in.; height, 35 ft. 2 in.

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Steel in the Stocks

The annual report of the British Iron and Steel Federation for 1955 shows that in spite of a rise in crude steel production from 18·52 million ingot tons in 1954 to 19·79 million ingot tons in 1955, this country had to import 1·85 million tons of steel in all forms last year compared with just under half a million tons in the previous year. Home demand, after increasing by an average of 2·4 per cent. per annum over the five years up to 1954, rose by about 6 per cent. in 1955. In order to keep the home market supplied the industry was forced to restrict exports to some extent—though total exports rose by just under half a million tons.

An apparent anomaly was that in spite of the general stringency of supplies, producers' and consumers' stocks of steel increased during 1955

Projected Convair jet air-liner.

by 00,000 tons. If this increase could have been avoided the steel import bill would have been reduced by almost 40 per cent. Nearly half the increase occurred in producers' stocks and may have been due in some measure to the dislocation caused by the railway and dock strikes in May and June, the effects of which were felt for some months afterwards. The railway strike may also have induced consumers to expand their stocks as a precaution.

The provision of additional steel output capacity takes considerable time. It is therefore difficult to avoid shortages whenever exceptional increases in demand occur. But it is encouraging to note that many schemes have been started to increase the output of certain types of steel. For instance the programme of John Summers and Sons, Limited, which includes three new open-hearth furnaces during 1956, envisages an expansion of some 80 per cent. to a production of 1·65 million tons of steel per annum. The Steel Company of Wales Limited will also instal three more open-hearth furnaces later in 1956, and when their programme is complete steel production should rise to 2·4 million tons a year compared with 1·8 million tons in 1955. Steel, Peech & Tozer hope to install a new hot strip mill at the end of 1956 from which production is expected early in 1957.

From other information included in the report it is apparent that the United Kingdom, despite output records in 1955, is still lagging behind the increases shown by the rest of the world. World crude steel production for 1955 expanded by over 20 per cent., compared with the United Kingdom increase of 7 per cent. Meanwhile U.S. production expanded by 33 per cent., E.C.S.C. output by 20 per cent., and U.S.S.R. and Eastern Europe production by 10 per cent. Even though the credit squeeze is affecting the demand for steel slightly in this country, there should be no danger of excess capacity while world demand for steel continues to expand rapidly. British steel is cheap and there would be a ready market for it overseas even if demand in this country should slacken temporarily. The development schemes under the second post-war development plan should be completed by 1958 and the Advisory Committee of the Federation is now reviewing the next phase of development.

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Conscientious Objectors to Industry

If artists who are not also engineers are encouraged to paint pictures of industry (and there are many good reasons for thus encouraging them), it is surely acceptable for an engineer who is not an artist to comment on the results.

An exhibition of industrial pictures which has been shown in London is being sent on a tour of the provinces this week-end by the sponsors, Richard Thomas and Baldwins Limited. This famous steel firm have undoubtedly acquired much public goodwill and admiration by encouraging painters " to search out the artistic possibilities of the industrial scene." Artists were not limited to subjects connected with the steel industry; they were not put to any expense; and no commission is charged on works sold at the exhibition. Prizes amounting to £1,100 have been awarded to fifteen artists, and 220 pictures have been selected from the 1,200 submitted.

Art critics have praised the high standard of the paintings. Many of the artists have created fascinating patterns and delightful colour compositions out of the harsh kaleidoscope of industry. In a few cases the sad, drab—even wistful—atmosphere of factories is evoked. But among the minority who have included human figures in their paintings, very few—in the eyes of one engineer—reveal evidence of a natural understanding of the men who work in foundries, assembly shops and the like. Perhaps many of them were adolescent conscientious objectors to modern industry, preferring the artistic freedom of the studio to the discipline of the works. If so, they must wrestle with their mature conscience; inwardly, they must acknowledge the fact that an environment of steel girders and belching furnaces is as significant to men in the Twentieth Century as Constable's cornfield and blue skies were to his fellows of 1826. They will doubtless derive encouragement from magnanimous companies. Maybe they will be heartened, also, by the belief, not uncommon among engineers, that the industrial scene has, indeed, artistic possibilities.

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Artificial Satellites

More details of the American artificial satellite programme have recently been released. The project now known as " Vanguard " was first announced by President Eisenhower at the beginning of August, 1955. It was intended that as many American manufacturers as possible should contribute to the vehicles, and during the past eight months the names of a number of the major contractors have been announced. Recent additions to the list are the Grand Central Rocket Company and the Allegany Ballistics Laboratory who will develop the third-stage solid-propellant rocket, the Minneapolis-Honeywell Regulator Company, who will build the gyro reference system, and Vickers Incorporated, who will make the auto-pilot. It is significant that the announcement of these contracts has been spread out over the period of time since the original Eisenhower statement. It would appear that this statement was made in the early paper-work stages of the project and, in view of the considerable amount of development required and the lateness in placing some of the contracts, there is a legitimate doubt if the first firing will be accomplished before December, 1958, as planned.

The actual orbit in which the early satellites are to be placed is very much a compromise. An equatorial orbit would allow the maximum use to be made of the Earth's angular velocity and would ensure that the satellite passed over the same ground on each revolution, thus easing the instrumentation problem. On the other hand, a circumpolar orbit would be of far greater use scientifically, but would make instrumentation very difficult. The compromise is a 40 deg. orbit which will have the added advantage of bringing the satellite into " view " of many of the countries participating in the International Geophysical Year, including Great Britain. The satellite will only be optically visible just before sunrise and just after sunset. In practice, it will be very difficult to pick up, even with a telescope, owing to its lack of brightness and its high speed.

Because of the uncertainty of complete success with the earlier vehicles, it is unlikely that too much reliance will be placed on internal instrumentation with a radio telemetry link. This can be deduced from the fact that the earlier satellites are to carry only batteries for power supplies, although later it is certain that silicon " solar " generators will be used to give supplies of electrical power for an indefinite period. Much useful information can be obtained from visual tracking on such matters as the oblateness of the Earth, the non-uniform distribution of its crust and, in the latter part of the trajectory, the density of the upper reaches of the atmosphere. The comparatively low cost of the optical equipment will facilitate the setting up of observation posts in all parts of the world.

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Vehicles with Hydraulic Drive

A paper on the application of hydrostatic transmission to tractors, given this week to the Institution of British Agricultural Engineers by Mr. H. J. Hamblin of the National Institute of Agricultural Engineering, comes at an opportune time. Interest in the subject is considerable, and widespread throughout the world. It is fruitless to speculate on how much of this interest stems from previous accounts of the work being done at the N.I.A.E. and how much has arisen quite independently. Probably the truth is that the N.I.A.E. work has acted as a nucleus around which people's thoughts have crystallised; this is most likely because the theoretical advantages of a hydrostatic transmission have been accepted for long enough, and the limitations of gear transmissions for tractors have become all to obvious.

Certainly the results given in the paper of early drawbar tests of the experimental N.I.A.E. tractor will give rise to increased interest. The optimum overall efficiency of the hydrostatic transmission was found to be very little different from that of a tractor with gears. This refutation of the common assumption that any sort of hydraulic drive is necessarily much less efficient than one with gears is particularly encouraging because it means that no special provision has to be made for heat dissipation. Another bogey of hydraulic equipment—excessive weight—was noticeable by its absence. In fact, it was pointed out that the general thickness of the motor casings was increased arbitrarily at one stage in the design, simply to add weight.

The question now is how quickly these results can be applied commercially. At first sight a major revolution appears to be involved. But a closer examination shows that this is not necessarily so. Of the three components of a hydrostatic transmission—the pump, the motors and the connecting pipes—it is only the pump that presents any difficulty. The motors can be simple, straightforward pieces of machinery. The components to make up a circuit can be purchased without any difficulty. Thus everything hinges on the development of a suitable pump. Commercial development work is believed to be proceeding. Maybe it will not be long before there are visible signs of commercial interest in the application of the system.

" General Ironworks, Earl's Court," a painting by Mr. A. Daniels which won a £100 prize in a competition sponsored by Richard Thomas and Baldwins Ltd. (see " Conscientious Objectors to Industry ").

ELECTROMAGNETIC PUMPS FOR LIQUID METALS

CIRCULATING REACTOR COOLANTS AND FUELS

By D. A. Watt, B.SC. (ENG.), A.M.I.E.E.*

The use of liquid metals as reactor coolants or as solvents for reactor fuels calls for a convenient and reliable means of pumping these highly radioactive and sometimes costly materials. The electromagnetic pump, which employs neither seals nor moving parts, seems the ideal solution to this problem, and in this article the more useful examples are briefly described. The author examines the elementary considerations affecting the design and application of compensated direct-current and travelling-field alternating-current pumps, which he regards as the most important versions, and gives a short overall survey of the electromagnetic pumping equipment developed by the United Kingdom Atomic Energy Authority. The article is based on lectures given at the Atomic Energy Reactor School, Harwell. (Some introductory remarks concerning liquid-metal pumps and details of pumps made by a private company are given on page 281.)

HISTORICAL

"Electromagnetic pumping" is now commonly understood to refer to pumps for liquid conductors in which the fluid pumped becomes in effect the "rotor" circuit of an electric motor as it passes through the pump. Electrical power is transformed directly into pumping power and the complexities of an intermediate mechanical stage are altogether avoided. The interaction of current and magnetic field in a liquid conductor was studied by Northrup who utilised the hydrostatic pressures produced in a pinch effect ammeter for measuring large alternating currents (1906-1910)[1]. In 1915, Chubb[2] proposed the use of sliding and rotating magnetic fields to produce motion of a liquid metal and described in particular a spiral-channel induction pump. In 1926 Bainbridge[3] proposed and tested an A.C. conduction pump depending on intensified pinch effect. In 1928, Einstein and Szilard[4] proposed an annular travelling-field pump and an A.C. conduction pump for use with alkali metals. These early pumps were mainly directed to providing the motive force for liquid jet pumps for gases and non-metallic liquids, as, for example, liquid ammonia in a refrigeration cycle.[4] More recently electromagnetic pumping principles have been applied in the die-casting industry[5], but the development of large and efficient pumps has received its greatest impetus from atomic energy projects. These have utilised the excellent heat-transfer properties of liquid metals in systems which are sometimes radioactive and operated at temperatures of 500 deg. C. or more.

* Reactor Division, Atomic Energy Research Establishment, Harwell.

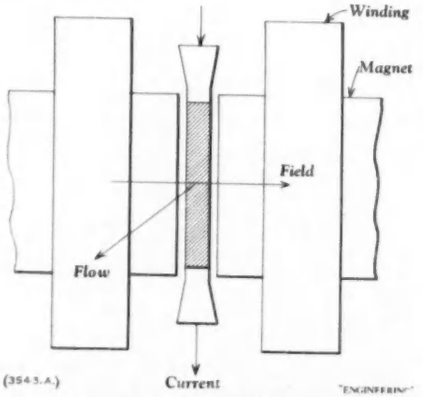

Fig. 1 Principle of conduction pump suitable for use with either A.C. or D.C. supply. An electric current traverses the liquid-metal which is exposed to a magnetic field perpendicular to the current; the metal is thus subject to a force at right angles to both current and field.

ELECTRIC MOTOR PRINCIPLE

There is an obvious comparison with electric motors, and electromagnetic pumps may be classified according to current supply, alternating-current or direct-current, and in the case of A.C., according to the method of producing current in the liquid-metal "rotor," by induction or conduction. In a conduction pump the source of electro-motive force is external to the liquid and current must pass via electrode surfaces in the pump channel. D.C. pumps are necessarily conductive. The most important type of induction pump is analogous to the induction motion in that a gliding or rotating wave-form of magnetic flux induces currents in the liquid "rotor" circuits by transformer action. Internal solid-liquid conduction surfaces are sometimes to be found in induction pumps and performance does depend quite significantly on good conductivity at these interfaces. Good conductivity can usually be assured by choice of appropriate electrode materials and by maintaining a reasonably high standard of cleanliness in the liquid circuit.

CONDUCTION PUMPS

The simplest type of electromagnetic pump is illustrated in Fig. 1 and is based on the conduction principle. Liquid metal flows in a narrow rectangular duct passing between the poles of an electromagnet and current passes through the liquid in the field region via electrodes connected along the narrow edges of the duct. D.C. or A.C. supply may be used but a laminated iron circuit and a suitably phased A.C. energised field winding is required for the latter. In each case there are end currents which follow curved paths in the entry and exit regions beyond the electrodes. It is usual to limit and make use of these currents by extending the field beyond the electrodes and artificially increasing the fringing field by tapering the magnet gap width.

Alternatively, in a very large pump where the breadth b might be equal to or greater than the electrode length c it may be preferable to insert hollow-type insulating baffles in the path of the end currents or to divide the entry and exit regions into a number of independent channels. This method would be quite effective in a large pump but does require an appreciable increase in channel length. The breadth b should preferably be less than half the electrode length c. Where baffles are used a sufficient number should be inserted to make the breadth of each subsidiary channel small compared with c. The field would be extended and graded to suit the width between baffles, as can be seen from Fig. 2.

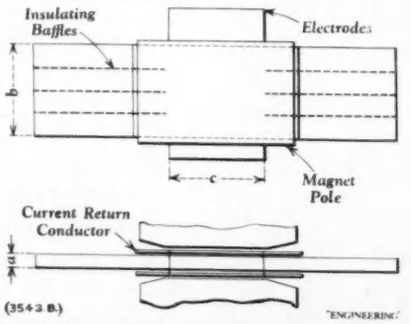

Fig. 2 Compensated conduction pump with baffles and shaped poles to control end currents.

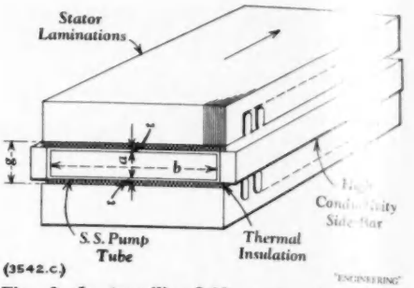

Fig. 3 In travelling-field pumps, the flow of liquid metal is distributed in a relatively thin sheet, possibly 1 in. thick in a large unit. The simplest example is the flat linear induction pump or FLIP, shown here diagrammatically.

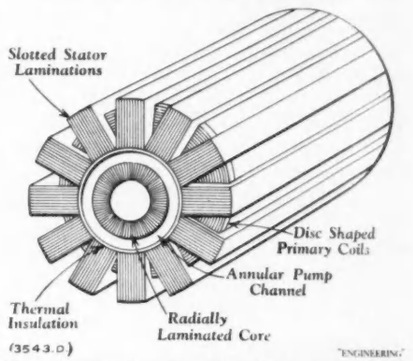

Fig. 4 Annular travelling-field pump shown diagrammatically. In this construction liquid flow is parallel to the axis and currents flow in closed circuits within the liquid; conduction surfaces at the channel edges are thus eliminated.

COMPENSATION

It is usually advantageous to compensate the D.C. pump by passing the main current back through the magnet gap. By this simple expedient any loss of power and efficiency through "armature reaction" can be practically eliminated. In the uncompensated pump there is an upper limit to the total developed pressure rise which, neglecting end effect, occurs when the distorting effect of the main current produces saturation flux density at pump entry, and zero field at outlet. The current is concentrated towards the outlet and in this limiting case the intrinsic efficiency Λ_i is 50 per cent.[6] The reduction in efficiency caused by current and flux distortion depends on the ratio $\frac{u\,c^*}{\sigma}$, and is smaller for high-resistivity liquid metals such as mercury and bismuth. For equal currents and mean gap field strength the developed pressure rise in the uncompensated pump can be substantially less than that of the compensated arrangement, even with these metals. Compensation would normally be adopted in this case as pressures of several atmospheres are likely to be required. The theoretical limit[6] of pressure rise in the uncompensated pump is about 150 lb. per square inch.

Two adjacent pump channels connected in series electrically can be designed to give exact compensation during operation. The flows are in opposite directions, however, and single-channel systems are usually preferred. In this case adequate current balance throughout the pump can be achieved by a suitable extension of the return current path to match the region of significant current flow in the entry and exit regions.[7]

Compensation can be applied to the A.C. conduction pump but is more complicated as in

* Symbols defined on page 265.

si[illegible]le-channel pumps the return current path m[illegible]t be divided into separate conductors conne[illegible]ted to independent current supply circuits. A.[illegible]. conduction pumps are generally used in small loops which require relatively low pressures and so in this case compensation is not in fact necessary.

TRAVELLING-FIELD INDUCTION PUMP

In travelling-field pumps, the flow of liquid metal is distributed in a relatively thin sheet, possibly 1 in. thick in a large unit. Polyphase windings in slotted stators are placed against the walls of the pump channel with a minimum of thermal insulation in between. The flat linear induction pump (FLIP) is the simplest to fabricate and the windings are readily removed, Fig. 3. In small sizes it is found advantageous to braze high-conductivity side-bars along the narrow edges of the channel. These are equivalent to the end-rings of an induction-motor rotor. In a large unit where the breadth b is four or five times the pole pitch, or half wave-length $\frac{\lambda}{2}$, the edge effect without side-bars would be of less significance. Where internal bracing of the channel is adopted to strengthen it against vacuum and pressure loads the currents must, preferably, be conducted through the bracing members. These may be I-section pieces welded along the entire length of the channel.

Conduction surfaces at the edges can be eliminated by the adoption of an annular construction of channel in which liquid flow is parallel to the axis and currents flow in closed circuits within the liquid. This system is illustrated in Fig. 4. For a given thickness of wall material the annular form has much greater mechanical strength. The inner wall of the channel may be a sealed cylinder containing the radially laminated core. This is very rigid and may be securely mounted by fins beyond the region of current flow and pumping action[8]. The winding is not so readily designed in a removable form and for this reason the annular linear induction pump (ALIP) has not been as widely tried as the flat version (FLIP).

To obtain as far as possible a pure travelling wave in the liquid it is important to grade the core flux or gap field over the end wave-length or pole pitch. This takes account of the fact that the winding does not close upon itself like that of an induction motor. A pump with fully wound end poles would incur a serious loss of efficiency through idle power dissipated in the liquid by ordinary eddy-current action. In the simplest arrangement, usually adopted in the flat pump, the end poles are half wound. In a two-layer winding the end poles would have one layer only. This is convenient as coils for an even number of fully wound poles would naturally leave the end poles half wound when developed[7]. The output from these end poles may usually be neglected but the input must be assessed in calculating the overall efficiency.

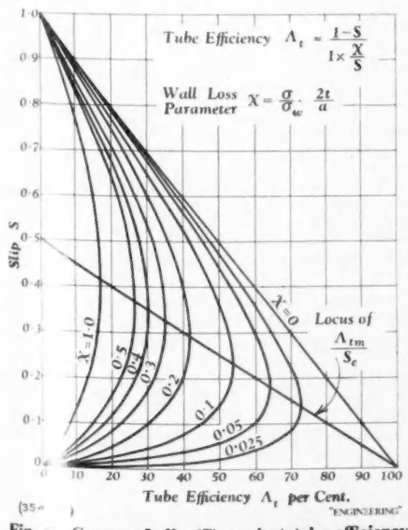
Tube Efficiency $\Lambda_t = \frac{1-S}{1+\frac{X}{S}}$
Wall Loss Parameter $X = \frac{\sigma}{\sigma_w} \cdot \frac{2t}{a}$
Slip S
Locus of $\frac{\Lambda_{tm}}{S_e}$
Tube Efficiency Λ_t per Cent.
"ENGINEERING"

Fig. [illegible] Curves of slip (S) against tube efficiency (Λ_t) [illegible] both D.C. and travelling-field pumps.

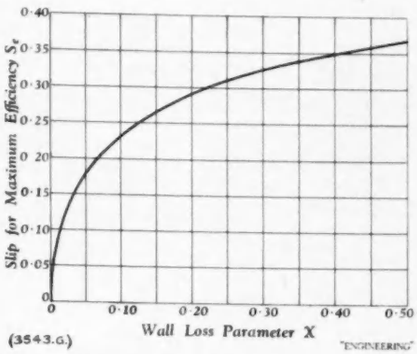

Fig. 6 Curve of slip for maximum efficiency (S_e) against wall parameter (X) (see Fig. 5).

The theory of the fully wound central regions of a travelling-field pump is comparatively simple[9]. The reactance of the liquid and wall current paths may be neglected provided the ratio of pole pitch to gap width is suitably large[8]. Current and flux in the liquid may be presumed in time and space phase. The magnetising component of stator current is related to the power component by a simple relationship and may be presumed in quadrature phase. The pressure-flow charateristic often exhibits a maximum in the positive flow range. This is due to the varying disposition of stator current into power and magnetising components, in contrast to the induction motor where both phase and magnitude of rotor currents govern the shape of the torque-speed characteristic. The large air gap of the pump involves a relatively large magnetising component of current and the gap field strength varies appreciably with slip, having a maximum value at the lowest operating slip.

SPIRAL-CHANNEL INDUCTION PUMP

Apart from the inherent relation between the power and magnetising components, the elementary considerations applicable to the design of the compensated D.C. pump provide a useful basis for understanding the channel design of travelling-field pumps. The behaviour of the fully wound central region of a travelling field pump is directly analogous to that of a compensated D.C. pump in that the power component of stator currents exactly balances the wall and liquid " rotor " currents, and the r.m.s. values of current and flux are uniform and in phase.

The spiral-channel induction pump (SIP) is a travelling-field pump, but is a more direct adaptation of the induction motor. An annular channel with a helical vane to promote axial flow is arranged in the widened gap of an induction-motor type stator with locked rotor laminations. The liquid " rotor " currents run mainly parallel to the axis and form closed loops via the liquid metal in the circular entry and exit regions. The helical vane must obviously make good electrical contact with the liquid metal. There are circumferential components of current in the magnet gap due to the axial component of flow. This involves a reduction in efficiency compared with the linear travelling field pumps, the difference depending on the angle of the helix. The spiral pump is most useful where the pressure rise required is inconveniently large for the rate of flow required and would involve a long, narrow channel in the developed form.

There are many varieties of electromagnetic pump, including centrifugal designs, but with few exceptions these are basically conduction or travelling-field pumps. Many of them are of limited practical interest, with the notable exception of varieties of small A.C. conduction pump and transformer combinations. Original work on one of these[10] led to an idea for a large-scale single-phase induction pump,[11] in which the winding could be shielded from the high-temperature radioactive sodium coolant in a reactor loop. Fabrication difficulties have prevented its development, but the small laboratory counterpart with pump tube in a single-turn copper secondary winding has given useful service in sodium loops operated at 350 deg. C. and 450 deg. C. Laboratory pumps of this kind are shown in Figs. 15 and 16.

BASIC THEORY OF CHANNEL DESIGN

Consider unit volume of a liquid conductor situated in a uniform magnetic field of strength H, and suppose a current i amps per square centimetre to pass through the liquid perpendicular to the field, as indicated in Fig. 7. There will be a developed pressure gradient, $h = \frac{H\,i}{10}$ dynes per sq. cm. per cm. in a direction perpendicular to field and current. (Fleming's left-hand motor rule). Permeability $\mu = 1{\cdot}0$. If uniform flow at speed u cm. per sec. is permitted, work is done on the liquid. The power output

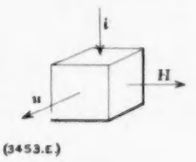

Fig. 7

$$w_o = h\,u\,10^{-7} = i\,H\,u\,10^{-8} = i\,e \text{ watts per cub. cm.} \quad . \quad . \quad (1)$$

where back E.M.F. generated

$$e = u\,H\,10^{-8} \text{ volts per cm.} \quad . \quad . \quad (2)$$

The power absorbed in ohmic heating

$$w_f = i^2\,\sigma \text{ watts per cub. cm.} \quad . \quad . \quad (3)$$

where σ = liquid-metal resistivity in ohm-cms.

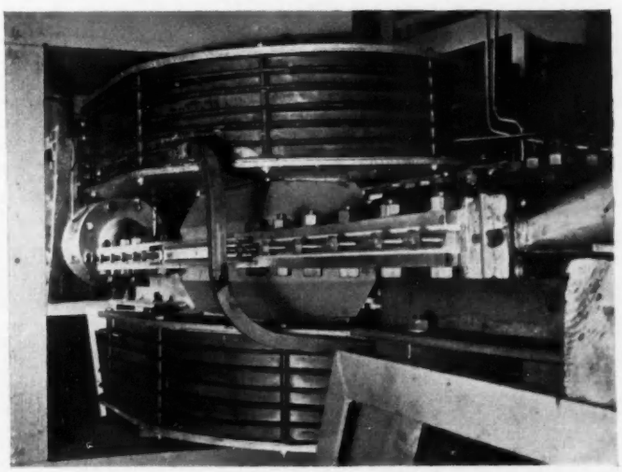

Fig. 8 Direct-current conduction pump (A.E.R.E., Harwell); detail of channel and magnet poles. The pump is compensated by return conductor sheets of copper extended into the entry and exit regions.

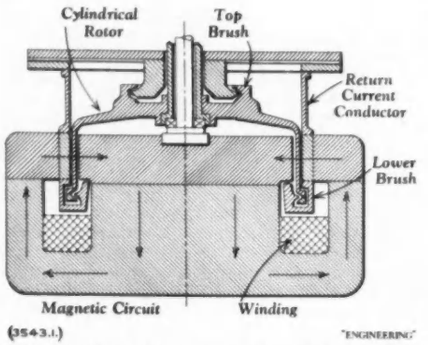

Fig. 9 Homopolar generator with mercury brush rings. It has produced 10 kW of low-voltage power suitable for a D.C. pump of the kind shown in Fig. 8.

The efficiency of this elemental motor is

$$\Lambda_I = \frac{i\,u\,H\,10^{-8}}{i\,u\,H\,10^{-8} + i^2\sigma} = \frac{u\,H\,10^{-8}}{u\,H\,10^{-8} + i\,\sigma} = \frac{e}{e + i\,\sigma}. \quad (4)$$

This equation may be applied to r.m.s. values of the alternating current and field provided allowance is made for any phase difference.

The intrinsic efficiency Λ_I will be constant over any region in which flow speed and time mean of field strength and current are constant. This is the usual case in the central region of the compensated D.C. pump or travelling-field A.C. pump.

If σ only is considered to vary the efficiency varies in inverse manner but the power rating w_0 watts per cub. cm. remains constant. If resistivity is considered to increase the current density must be decreased and the field strength increased to maintain both intrinsic efficiency and output power per unit volume at the same flow rate. This will be referred to again when the appropriate applications of D.C. and A.C. pumps are considered.

LOSSES

When the liquid conductor is contained in a relatively narrow pump channel the speed of flow varies across the width and there will be a circulating component of current in the liquid as it passes through the field of the pump. This is usually taken into account in assessing the hydraulic losses. The effect of the field may be to reduce the hydraulic loss under certain circumstances as turbulence tends to be suppressed.[12] Apart from this effect the liquid in the central region of a pump may be treated as a solid conductor in uniform motion.

The channel walls are an important source of loss as welded stainless-steel construction must be used in the engineering applications of high-temperature liquid metals. The wall loss is treated as a resistive load in parallel with the liquid "motor" load and has an important influence on the design conditions for optimum efficiency.

EFFICIENCY

The expression for intrinsic efficiency may be written

$$\Lambda_I = 1 - S \quad . \quad . \quad (5)$$

where

$$S = \frac{i\,\sigma}{e + i\,\sigma} = \frac{i\,\sigma}{v} = \frac{u_s - u}{u_s} \quad . \quad (6)$$

and may be defined as the ratio of ohmic loss in the liquid to total input to the liquid. This is the "slip" fraction of a travelling-field a.c. pump with wave speed u_s. In this case

$$i = (u_s - u)\,H\,10^{-8}. \quad . \quad (7)$$

In a D.C. pump the synchronous speed is that at which the generated back E.M.F. would be equal to the applied voltage gradient, v volts per centimetre.

$$v = u_s\,H\,10^{-8}. \quad . \quad . \quad (8)$$

Let the ratio of total wall conductivity to the liquid metal conductivity be denoted by

$$X = \frac{2\,t}{a}\,\frac{\sigma}{\sigma_w} \quad . \quad . \quad (9)$$

where t = single wall thickness, σ_w = resistivity of wall material, and

a = width of liquid current path; σ is as above.

At zero flow, $u = 0$, the wall current will be X times the liquid current. When pumping occurs there is a back E.M.F. in the liquid and the voltage gradient in the channel walls is $(e + i\,\sigma)$. The wall current

$$I_w = \frac{e + i\,\sigma}{i\,\sigma}\,X\,I_L = \frac{X}{S}\,I_L$$

or wall : liquid current ratio

$$\frac{I_w}{I_L} = \frac{X}{S}. \quad . \quad . \quad (10)$$

The efficiency of the wall and liquid combination in the central region of a compenstated D.C. pump or travelling-field pump may be written

$$\frac{1 - S}{1 + \frac{X}{S}}. \quad . \quad . \quad (11)$$

This expression has a maximum when

$$S = S_e = -X + \sqrt{X^2 + X}. \quad (12)$$

The maximum "tube" efficiency

$$\Lambda_{tm} = 1 - 2\,S_e \quad . \quad . \quad (13)$$

Curves of Λ_t and S_e are shown in Figs. 5 and 6. For $\Lambda_{tm} = 50$ per cent., $S_e = 0{\cdot}25$ and $X = 0{\cdot}125$.

Sodium and stainless steel have a favourable ratio of resistivities, $\frac{\sigma}{\sigma_w} = 0{\cdot}25$ or less, so that "tube" efficiencies greater than 50 per cent. can be realised in quite narrow channels, for example $a = \frac{1}{2}$ in., with reasonably thick walls, $\frac{1}{16}$ in. to $\frac{1}{8}$ in. In the case of mercury, lead and bismuth the liquid resistivity usually exceeds that of the wall material and the liquid width, a, must be substantially increased to avoid serious reduction in efficiency. Wide channels, $a > 2$ in., are practicable in the D.C. pump but not in travelling-field designs, which have a virtually fixed current loading (ampere-conductors per centimetre). This entails very low rates of pressure rise in wide channels.

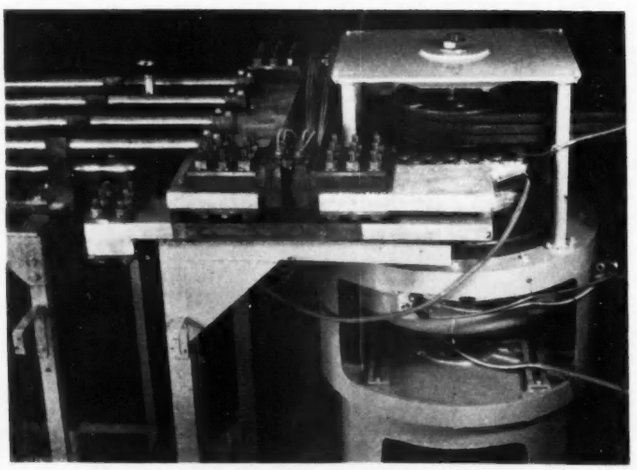

Fig. 10 Further view of homopolar generator illustrated in Fig. 9.

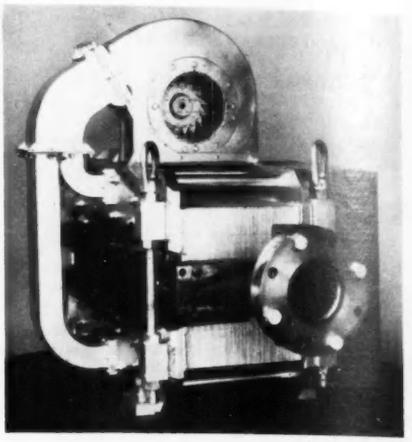

Fig. 11 Flat linear induction pump (FLIP) designed and built by the English Electric Company, Limited. It has an air cooled stator and is rated at 400 gal. per min.

The chosen design condition is not necessarily that for maximum efficiency. The condition for maximum output power is equally important in A.C. travelling-field pumps as it has an obvious bearing on pump size and weight. The two conditions usually occur within 15 per cent. difference of slip and in optimum electrical design they occur at the same value of slip.[9] In compensated D.C. pump design it is usually possible to obtain a high power rating at the optimum efficiency condition.[9] The magnetising current and liquid currents are not inherently related as in the travelling-field pump. Even where series excitation is used it is possible to choose the rate of pressure rise, dependent on Hi, so that an integral number of series turns will produce a gap field strength corresponding to the optimum ratio of H/i; see equations (4), (5) and (12). Such a system does assume a constant flow since the optimum H/i ratio will vary with flow speed u.

TWO BASIC DESIGNS COMPARED

The D.C. and travelling-field pumps in their basic form with straight-through channels welded in the line of run of the hydraulic circuit are the only designs of interest in the large-scale pumping of liquid-metal coolants. There are important features of theoretical design which decide the appropriateness of each. The travelling-field pump with its polyphase winding distributed in slots must have a fairly narrow channel, $a = 1$ in. or less, in order to develop a practically acceptable rate of pressure rise, for example 0·5 lb. per sq. in. per cm. The rates of pressure rise are quite small because of the limited current loading and low gap field strength which are practicable without undue copper loss, thermal difficulties and magnetic saturation of the core. Typical figures are 1,000 to 1,500 ampere conductors per centimetre and 2,000 gauss r.m.s. gap field.

It is fortunate that sodium and stainless steel have resistivities which lead to reasonable pumping efficiency in the narrow range of channel widths even with quite thick walls, for example $a = \frac{1}{2}$ in. to 1 in., $t = \frac{1}{8}$ in. Sodium is favoured also for its low density and therefore the low pumping pressures required. 100 ft. head of sodium is equal to 37 lb. per square inch approximately. Thus high speeds may be used in narrow channels without undue hydraulic loss and the length and breadth of pump is found to be acceptable in units of 2,000 to 3,000 gal. per minute capacity and developing over 100 ft. net head of sodium. In units of this size efficiencies of 35 to 40 per cent. are possible with sodium. The efficiency of a similar unit designed for sodium-potassium alloy is inevitably reduced because of the increase in wall-liquid conductivity ratio; see equations (12) and (13).

In a D.C. pump much stronger gap fields can be

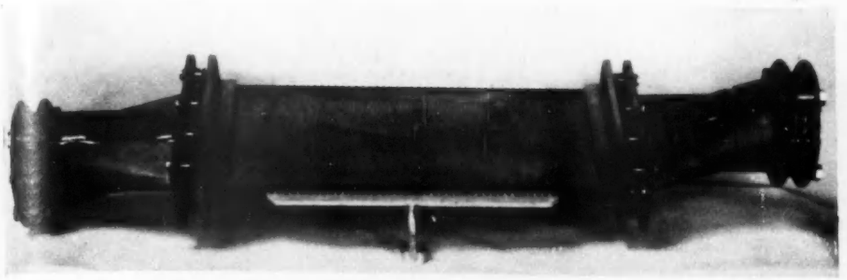

Fig. 12 Pump channel and diffusers of flat linear induction pump shown in Fig. 11.

used with relatively low magnetising power, and channel widths may be chosen to give an acceptable "tube" efficiency and a voltage : current ratio to suit the design of the current source.[13 14] The American prototype sodium-cooled EBR II fast-reactor design has a single D.C. pump of 10,000 U.S. gal. per minute capacity. This has a channel width $a = 6$ in. and breadth $b = 18$ in., with electrode length $c = 24$ in.; a split-channel system and extended poles are used to control the end current loss.[15 16] The split channel would also appear to serve a hydraulic function at each right-angle bend in the entry and exit lengths. A homopolar generator current source is to supply 250,000 amperes to the pump via sodium-filled stainless-steel ducting with blocks of copper immersed adjacent to the pump channel and in the reactor shielding adjacent to the generator. This serves to indicate what can be contemplated with a D.C. system. The connection of the current supply is such as to form a single-turn winding on the magnet. The channel widths, a and b, have no doubt been carefully chosen to give the best overall combination. Relatively high rates of pressure rise are possible in a D.C. pump, 7 lb. per sq. in. per cm. or more, but this has little advantage in the case of sodium. It is clear, however, that a D.C. pump may be designed to handle flows greatly in excess of that practicable in one flat travelling-field pump. In a very large system such as the 500 MW EBR II design study it may be preferable to avoid undue multiplicity of pumps, power supply and control gear. The power factor of the supply is inevitably poorer with the A.C. system, 0·4 to 0·5, and on account of this and a small difference in efficiency the kVA demand is likely to be double that of a D.C. system for sodium. The efficiency of a very large D.C. system including generator losses could be 50 per cent. for sodium.

Sodium-potassium alloy is not likely to be applied as a reactor coolant owing to the high neutron absorption cross-section of potassium. However, it can be conveniently pumped by travelling-field A.C. units if used in secondary heat-transfer circuits. The resistivity of the eutectic, 22/78, sodium-potassium alloy is about 50 microhm-cm., roughly midway in the range sodium to bismuth, 15 to 140 microhm-cm. Efficiencies are usually less but this is of little significance as the pumping power required is small.

PUMPING BISMUTH

Bismuth is of interest as a coolant because of the possibility of dissolving sufficient uranium in it to make a liquid-metal fuel reactor. The solution is both fuel and coolant. In view of the high density of bismuth, $\rho \simeq 10$ gm. per cub. cm., the pumping pressures required are likely to be in the range 100 to 200 lb. per square inch. The difference compared with sodium is not as great as the ratio of densities would suggest because it seems likely that fairly low flow speeds must be used to avoid cavitation and erosion troubles. Any form of travelling-field pump is at a serious disadvantage because of the low intrinsic efficiency that must be adopted to develop the same order of pressure rise per unit length practicable with sodium. The gap field strength cannot be much increased, so the wave speed must be raised to generate the increased voltage required to produce the same current density in the liquid. With reduced flow speed this inevitably involves a low intrinsic efficiency; see equations (5) and (6). The wall loss is correspondingly more significant (equation 11). An operating slip as high as 70 per cent. may have to be adopted to avoid undue hydraulic loss. It is not practicable to operate at the condition for maximum tube efficiency which always occurs at less than 50 per cent. slip.[9] With the same rate of pressure rise as for a sodium pump, the length required will be twice or three times and it may be preferred to arrange smaller size units in series. The lower flow speeds require a corresponding increase in breadth of pump channel for a given flow. This implies a poorer power : weight ratio and a lower limit to the maximum flow which could be handled by a single pump. On account of the serious reduction in efficiency and the larger pumping power likely to be required the supply kilo-volt-amperes might be an order of magnitude greater than that for a similar system using sodium. This is a serious consideration, especially in view of the poor power factor.

SCOPE OF THE D.C. PUMP

The D.C. pump is well suited to pumping the high-density high-resistivity liquids. The intrinsic efficiency Λ_I can be kept as high as that for sodium by using a sufficiently strong gap field intensity to offset the increase in resistivity and any decrease in flow speed (equation 4). This implies a better voltage : current ratio for a given channel width a. Alternatively for the same voltage : current ratio the channel width can be increased to offset the increased wall loss though it would not be practicable to keep to sodium range values of conductivity ratio X (equation 9). The detail is complicated but one would expect higher rates of pressure rise to be adopted and the overall efficiency to be within 10 per cent. of that possible in the same size of pump for sodium. The power : weight ratio would be greater and despite the length of magnet yoke may be better than that possible in a travelling-field pump designed for sodium.[9] The hydraulic loss is of little significance in channels 2 in. wide or more, so that flow speeds may be as high as considerations of erosion and satisfactory diffuser design allow.

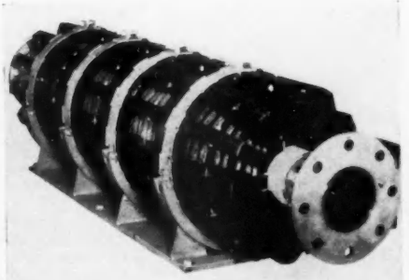

Fig. 13 Annular linear induction pump (ALIP) designed and built by the Britsh Thomson-Houston Company, Limited. The pump, which is shown with cover removed, can pump at a rate of 525 gal. per min. and has been operated at a liquid temperature of 175 deg. C. (See Fig. 14.)

TEMPERATURE AND OTHER FACTORS

Operation at liquid temperatures approaching the Curie point of the magnetic material, and exceeding it in small sizes[16], may be more readily realised in varieties of conduction pump than in the induction type with polyphase distributed windings adjacent to the pump channel. There is virtually no insulation problem in the conduction pump with single or two turn heavy winding, whereas the polyphase winding cannot be operated above the temperatures found possible with inert atmosphere enclosure of the winding. If the liquid temperature is to exceed this limit a substantial layer of thermal insulation must be inserted between the channel and stator, and air or liquid cooling applied to the stator iron. In an active sodium loop the intense γ-radiation introduces a further hazard which is absent in the conduction pump. The development and proving of materials is proceeding but will take time. At temperatures of the order of 500 deg. C., the low mechanical strength of copper and the tendency to flow will require novel methods of mounting conductors in slots. The travelling-field pump would appear to be best suited for relatively low-temperature alkali metal applications where class-H silicone-varnish impregnated glass fibre and mica insulation can be operated without special cooling. Enclosure of the winding in an inert atmosphere raises the maximum operating temperature above 250 deg. C.

The liquid-metal circuit would normally be designed to avoid gas entrainment because of the known adverse effect on heat-exchanger performance. Laboratory-size electromagnetic pumps with channels $\frac{1}{8}$ in. wide or less can be completely stalled by gas bubbles collecting in the pumping region. Provided the channel is mounted so as to allow gas to pass freely through the pump, large units, both conduction and induction, are unlikely to be so radically affected.

The D.C. pump requires a special source of current but its other advantages make this development profitable. Considerable progress has been made in the development of homopolar generators and the EBR II proposal is an outstanding example of the large-scale application of the D.C. system. The homopolar generator and motor constitute a rotary transformer of good efficiency coupled to the pump by relatively flexible sodium-filled stainless-steel conductors.

PUMPS DEVELOPED BY U.K.A.E.A.

Experimental D.C. Pump made by A.E.R.E., Harwell (Fig. 8).—Some details are as follow. Measured performance with mercury: $60\frac{1}{2}$ gal. per min.; 44 lb. per sq. in. net; 10,400 amps electrode current at $\frac{3}{8}$ volt potential difference, i.e. $35\frac{1}{2}$ per cent. efficiency excluding magnet power. The hydraulic loss is serious in a narrow channel but at about 30 gal. per min. the measured maximum efficiency is nearly 40 per cent. The channel dimensions a, b and c are $\frac{3}{8}$ in., 6 in. and 14 in. respectively. The poles are 16 in. long. The channel had not been fitted with insulating baffles but shaped pole-face extension pieces were added. Without these the best efficiency is about $2\frac{1}{2}$ per cent. less. The wall material is 18/8 stainless steel sheet, 0·025 in. thick. The pump is compensated by return conductor sheets of copper extended into the entry and exit regions. No significant armature reaction effect could be detected although search coils were arranged throughout the magnet gap.

Homopolar Generator with Mercury Brush Rings, A.E.R.E. design[14], drawn and manufactured by A. Frazer Nash and Palatine Tool and Engineering Company, Limited (Figs. 9 and 10).—This experimental machine has produced 10 kW of low-voltage power suitable for the D.C. pump just described. It supplies a current of 10,000 to 16,000 amps, at an overall efficiency of 90 per cent. excluding the drive. A bell-shaped copper rotor with hollow-type

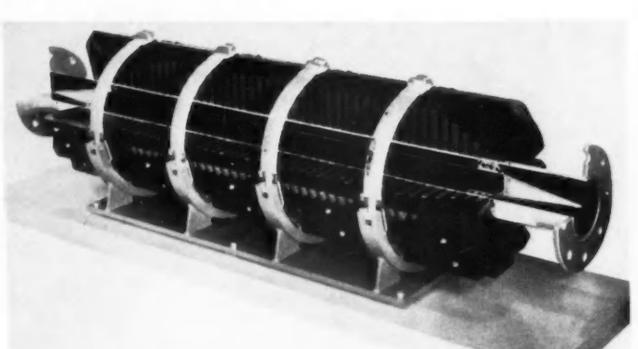

Fig. 14 Sectional view of ALIP illustrated in Fig. 13.

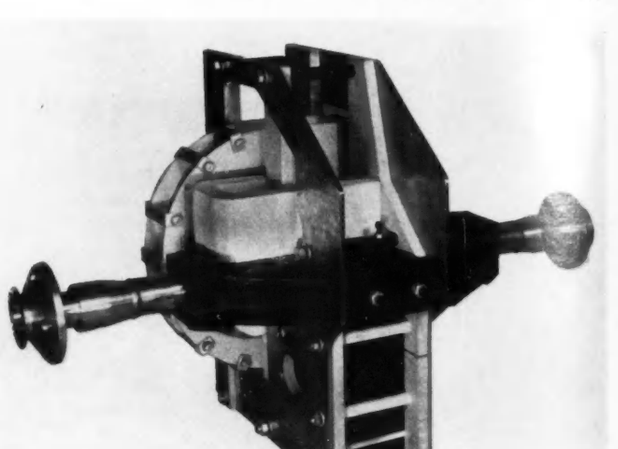

Fig. 15 Small single-phase laboratory pump for sodium. The production model was made by A. Frazer-Nash and the Palatine Tool and Engineering Company, Limited.

mercury collector rings rotates in an annular magnet gap (see Fig. 9). When the external circuit is closed, current flows via the mercury rings with a very small voltage drop—about a millivolt. A small circulation of mercury keeps the rings filled and provides cooling. A large machine suitable for the D.C. pump could be designed with an overall efficiency of 95 per cent. Development of this machine has proceeded slowly and the use of relatively thin plating on the copper brush surfaces led to serious corrosion difficulties. In a large machine other materials could be used for the brush rings and in any case a heavy deposit of nickel is expected to extend the useful life of copper rings quite considerably. The machine was run for over 200 hours in March and April, 1955, and tests are proceeding.

TRAVELLING FIELD PUMPS

Flip Units designed and built by the English Electric Company, Limited (Figs. 11 and 12).—These 400 gal. per min. units were designed to give a pressure rise of 30 lb. per sq. in. when pumping sodium at 250 deg. C., with 30 per cent. estimated efficiency. The performance with sodium-potassium eutectic alloy is much poorer on account of the increased liquid resistivity. At 400 gal. per min. and the same stator current the pressure rise is about 15 lb. per sq. in. and the efficiency 23 per cent. The flow speed in the channel is 28 ft. per sec. This design has a pole pitch of about 5 in., channel cross section 10 in. by 0·55 in. and walls of $\frac{1}{16}$ in. 18/8 stainless-steel sheet. There are three fully wound poles and two half-wound end poles. Silicone-varnish impregnated glass and mica insulation is used, with air cooling of the stators by the small fan and ducting shown in the illustration, Fig. 11.

ALIP Unit, designed and built by the British Thomson-Houston Company, Limited (Figs. 13 and 14).—This annular pump was designed for operation with 22/78 sodium-potassium alloy at 100 deg. C., producing 10 lb. per sq. in. net head at 525 gal. per min. Tests have verified this estimate and the pump has been operated at a liquid temperature of 175 deg. C. At 400 gal. per min. the net pressure rise was 15 lb. per sq. in. and efficiency 35 per cent. With sodium at the same temperature an efficiency of over 41 per cent. would be attained. In this design the insulation is of class-B materials with forced air cooling to limit the winding temperature. The channel dimensions are width $a = 0{\cdot}67$ in., mean circumference $b = 9{\cdot}7$ in. and length about 40 in.; walls are of nimonic alloy 0·020 in. thick. The pole pitch is 5·05 in., and there are four fully wound poles and two with graded windings at each end. At 525 gal. per min. the channel speed is 31·5 ft. per sec.[8]

LABORATORY PUMPS

Two models of a combined pump and transformer are shown in Figs. 15 and 16. The principle and experimental development has been described elsewhere.[10, 11] Briefly, a single-turn series-wound conduction pump is combined with a single-turn transformer. Transformer and pump have one limb of the iron circuit in common and the single turn. The transformer primary winding can be supplied direct from standard A.C. mains. To ensure that adequate voltage is applied to the pump electrical circuit the core cross-section of the transformer can be greater than that of the pump. The smaller version illustrated has a capacity of 10 gal. per min. of sodium or sodium-potassium alloy and produces a head of 10 lb. per sq. in. at this flow. These units have been operated for hundreds of hours at temperatures up to 350 deg. C. The larger model has a thicker wall, 0·04 in. compared with 0·022 in.; this eliminates vibration problems but involves a substantial increase in supply kVA and weight for a similar performance. At 10 gal. per min. the pressure rise is 13 lb. per sq. in. This model has given thousands of hours of satisfactory operation in circuits with liquid temperatures up to 450 deg. C. Either of the models may be obtained through U.K.A.E.A.

MINIMUM MAINTENANCE

In the nuclear power applications of liquid metals there are few if any pumping requirements which cannot be met quite conveniently by electromagnetic pumps. In large sizes these can have channel walls $\frac{1}{8}$ in. thick and can be simple, rugged and very reliable. In terms of pumping efficiency and power: weight ratio optimum designs are likely to compete quite closely with the various forms of mechanical pump adapted to handle liquid metals. Efficiencies of near 40 per cent. and a power: weight ratio of 25 h.p. per ton, or better, can be expected in the appropriately applied electromagnetic pump system. The primary requirement, however, is for equipment which will be very reliable and need virtually no maintenance while in operation. The simplicity of the electromagnetic pump suggests that it has an especially favourable prospect of meeting these stringent conditions. The scope of electromagnetic pumps in respect of liquid temperature, degree of radioactivity, and possible abrasive properties is probably greater than that of mechanical forms. The single-turn conduction pump, having no problems of motor insulation and no moving parts, may be more readily adapted.

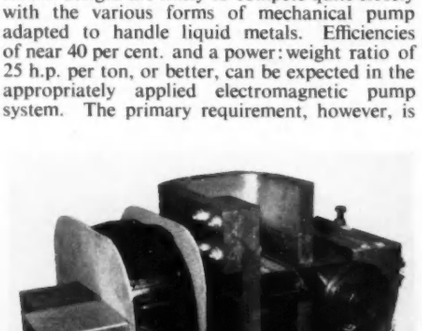

Fig. 16 Single-phase laboratory pump for sodium. The unit was conceived by the United Kingdom Atomic Energy Authority, Risley, and made by Campbell and Isherwood Limited.

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Institute of Metals Spring Meeting

MATERIALS FOR NUCLEAR POWER ENGINEERING

The forty-eighth annual general meeting of the Institute of Metals opened on the evening of April 10 at the Royal Institution, London, when Dr. Willis Jackson, F.R.S., director of research and education, Metropolitan-Vickers Electrical Company, Limited, delivered the 46th annual May Lecture on "Ferroelectrics—the Dielectric Analogue of Ferromagnetics." The chair was occupied by the President, Dr. Maurice Cook.

FERROELECTRICS

In the course of his lecture Dr. Jackson stated that recent years had witnessed the emergence of new applications for a number of metals which previously had been comparatively rarely employed. Thus the electrical properties of germanium and particularly its conductivity had been of great importance in the war-time development of radar. The successful operation of this type of equipment involved the production of large single crystals of germanium of very high purity. Such metals as uranium, plutonium and thorium were making possible nuclear-power generation, and zirconium, beryllium, sodium, bismuth and other metals were finding increasing uses in nuclear and ancillary applications. The properties and characteristics of various compounds, among them barium titanate, opened up great possibilities in the field of ferroelectrics.

On the three subsequent days, business and simultaneous technical sessions were held; the first technical session is reported below.

NUCLEAR POWER MATERIALS

The chair was occupied by Mr. G. L. Bailey, C.B.E., chairman of the Institute's Nuclear Energy Committee and the afternoon was devoted to a discussion on the theme: "Materials for Nuclear Power Engineering," based on three papers submitted from the United Kingdom Atomic Energy Authority and presented to the meeting by Dr. Ivor Jenkins, acting as *rapporteur*.

The first paper was by Dr. H. K. Hardy, who dealt with "Metallurgical Research and Development for Nuclear Power" and stated that the expanding demand for electricity could be met only by power derived from nuclear energy.

A decision to build a nuclear power reactor imposed a time-table on the research and development work, in which a balance must be struck between the problems posed and the ability to provide satisfactory solutions by the correct date.

The second paper, on "Metallurgical Research in Nuclear Power Production," was by Mr. J. G. Ball, who stated that the metallurgist engaged in nuclear-energy research was concerned chiefly with materials which had been little studied in the past. The metallurgical work relating to thermal reactors for power production centred round the cooling medium and the fuel elements, and metallurgical problems associated with reactors could be summarised under five headings. These were irradiation stability of the fuel element, thermal stability of the fuel element, sheathing materials, corrosion, and fabrication. Under each of these headings alloying was of importance and it was with the development and investigation of alloys for particular service conditions that the metallurgist in nuclear energy was much concerned.

The third paper, on "Nuclear Power Engineering," was by Dr. A. B. McIntosh and Dr. K. Q. Bagley, of the Culcheth Laboratories. The title was "Selection of Canning Materials for Reactors Cooled by Sodium/Potassium and Carbon Dioxide." Dealing with the requirements of a can, the authors stated that, in service, the greatest neutron flux, the highest temperature, and the most severe stress and corrosive conditions existed in the fuel element. Because uranium (or thorium if it were used) was not corrosion-resistant and had low mechanical strength, it must be protected from the cooling medium by a can which might have to be capable of providing support for the fuel if necessary. The can would also prevent the escape of fission products which might cause embarrassing contamination of the cooling medium. In addition to strength and corrosion resistance, which were the normal pre-requisites of a heat-resistant material, each design of reactor required a specific combination of nuclear, mechanical, physical and chemical properties.

The present work had indicated that metals such as beryllium, zirconium, niobium, vanadium, tungsten and molybdenum, were likely to play an important part in reactor technology, provided that difficulties in extracting and fabricating them could be overcome. Of all the elements examined, tungsten was the one most nearly inert to uranium and future developments of fast reactors designed to increase the temperature of the fuel-can interface or to use liquid alloys might depend upon the preparation of pure tungsten in a form capable of fabrication.

At all temperatures, beryllium appeared to be the most suitable container material, provided that the problems associated with its lack of ductility at low temperatures and with its fabrication characteristics could be solved. Beryllium was limited in its application on account of the difficulties associated with its extraction and fabrication.

DISCUSSION

Dr. Ivor Jenkins, who acted as *rapporteur*, said that in 1955 a Government White Paper had described an ambitious United Kingdom programme for the development and utilisation of nuclear power to meet the ever-increasing demands for electricity. The implementation of this programme would mean that, within the next ten years, nuclear power plants would contribute approximately 2,000 MW of electricity to the national needs, or a quarter of the expected increased demand.

Dominating the whole scene was the need to work to a somewhat rigid time-table if the national programme for reactor development were to be successfully implemented.

Mr. E. W. Colbeck, who opened the discussion, said that a rapid change had occurred last year with regard to security conditions, and this had enabled the Geneva Conference to take place and a number of papers which up to that date had been classed as "Top Secret" to be given. It was very pleasing that that afternoon it was possible to indicate the very considerable effort that British metallurgists had made in this field of atomic energy.

It was interesting to note that the first scientific team on metallurgy had been formed at the Royal Aircraft Establishment at Farnborough, and this had eventually provided the nucleus for the metallurgical laboratories at Harwell. All metallurgists would feel a sense of satisfaction that the old classical methods of approaching metallurgical problems still applied to the new field of atomic energy and that standard methods of experimentation and ingenuity on the part of the metallurgist still had their rewards.

Dr. L. Wyatt said that the three papers before the meeting had shown that the metallurgical work leading to the design and construction of a reactor could be divided into three sections. First, there was the general research, which should be as free as possible within the framework of a general association with reactor problems. Secondly, there was a feasibility study, which should be approached by the selected investigator with an absolutely open mind. At the end of the feasibility study commenced what, from the point of view of the metallurgist, could best be described as the process of discounting research forward. This meant that he told the engineer that if he proceeded along the lines laid down by the feasibility study he would get the solutions to his problems at the time he needed them. It was only from the end of the feasibility study that a rigid time-table was necessary.

Dr. W. E. Dennis stated that the greatest value of the three papers lay in the manner in which, by illustration, they showed how the metallurgy of a fuel element was developed. There were now more than 10 comparatively large metallurgical laboratories in this country engaged almost exclusively on work for the nuclear-power programme. The total annual supply of graduate metallurgists for the whole of British industry remained at little more than 100. Co-ordination and collaboration to ensure the proper application of available effort was, therefore, of primary importance.

Mr. G. W. Horsley said that his remarks concerned what one could do about controlling or minimising the oxygen concentration in a liquid-sodium cooling-medium circuit, in view of the excessive corrosion often caused by oxygen-contaminated sodium.

The ways in which oxygen, as dissolved sodium monoxide, could enter the circuit were (*a*) during the initial charging procedure; (*b*) by the reduction of oxide films on the walls of certain parts of the circuit; and (*c*) by continual leakage into the system through pores, micro-cracks, seals and glands.

When certain constructional materials were used, a "cold trap" for sodium monoxide could be placed in the circuit which, as far as was known at present, would cope satisfactorily with all three sources of oxygen. In certain types of sodium-cooled reactors, however, it might be necessary, on neutron-economy grounds, to use constructional materials such as zirconium to which on account of the high free energy of formation of zirconia, a cold trap would act, not as a sink for, but as a source of, oxygen. In this case it appeared that the reduction of the activity of sodium monoxide dissolved in the sodium might have to be effected by a combination of physical and chemical methods.

Mr. S. S. Smith referred to nomenclature and said that all present had accepted "growth" and "swelling" as defining two entirely separate phenomena or aspects of behaviour, whereas, to the uninitiated, these terms might well appear to be interchangeable. Another word which had given rise to difficulties was "ratcheting." It seemed hardly a suitable term to describe effects arising from differences in the thermal-expansion behaviour of the constituents of the fuel element. As to "fuel element" itself, it seemed a pity that such a term was used. "Cartridge" might be a better word, but he would not press this.

Dr. B. R. T. Frost said that in Mr. Ball's paper many of the disadvantages of using solid-fuel elements were mentioned, such as the swelling problem and the growth problem, and an obvious answer to these problems was to disperse the fissile material in a fluid medium There were three possible fluid media which sprang to mind. First, water could be used as a solution, and this had been successfully operated in the United States. The second possibility was fused salts, and the third, liquid metals. Liquid metals were superior on account of their lack of damage under radiation conditions and because of the possibility of going to much higher temperatures with them The choice of possible liquid-metal fuels, however, was severely limited. Possible metals were lead, tin, bismuth, sodium, lithium, mercury and gallium, all of which had low melting points. As mentioned in Mr. Ball's paper, bismuth was the favoured element for consideration as a liquid fuel medium.

Bismuth was not a pleasant metal to work with. Moreover, the corrosion problems with bismuth were fairly severe. The need for the solution of these and other problems was urgent.

To be continued

DOMESTIC HEATING IN GREAT BRITAIN

SPACE, WATER AND COOKING

By W. F. B. Shaw, B.A. (CANTAB)*

Concluded from page 236, April 20

In this concluding part of the article the first paragraphs deal with further solid-fuel appliances.†

Heat-storage Cookers.—This type of cooker has existed in a highly developed form for a number of years, and it is of interest to note certain fundamental differences between it and the freestanding cooker described last week. In the ordinary cooker the attainment of the different temperatures in the oven and on the hotplate, which are required for various types of cooking operation, lies in the hands of the user, who must boost or slow the fire when and as required. The heat-storage cooker, on the other hand, is always ready for use for any desired cooking operation. This is achieved by arranging that the fire burns at a slow and relatively steady rate under the control of a thermostat, and by providing several ovens maintained at different temperatures. The hot-plate is of massive construction, as will be seen from Fig. 5, with a heavy "tongue" of metal which acts as the heat-storage unit, protruding downwards into the fire. The speed of boiling is remarkably rapid provided that machined-base cooking pots are used; one model will boil three pints of water in three minutes.

A relatively low rate of fuel consumption is achieved, in spite of the fact that the cooker is maintained at full cooking temperature day and night, by the application of very heavy insulation at all points where heat could escape. A heavily-insulated bolster is also provided to cover the hot-plate when it is not in use.

Smokeless fuels must be burned, as the flue-ways are necessarily somewhat narrow. The heat extraction is so thorough that attention must be given to the avoidance of condensation troubles in the chimney to which the cooker is coupled. In some cases it is desirable to arrange for a deliberate warm-air bleed into the chimney at about ceiling level.

Boilers.—Boilers for domestic purposes cover a wide range of sizes and duties. Those of the smallest types are intended mainly for the supply of domestic hot water, while the large models provide central heating, and domestic hot water in addition where desired, for large houses or blocks of flats. For the purposes of the present review it will be sufficient to divide boilers into the following three groups:—

(*a*) Small boilers. Covering roughly the range 2 to 6 sq. ft. heating surface. Mainly for hot water but also for small or partial central heating.

(*b*) Sectional boilers. Covering roughly the range from 5 sq. ft. heating surface upwards. For the central heating of buildings over a wide range of sizes.

(*c*) Gravity-feed boilers. Central heating and hot water for the larger private houses.

Boilers are normally operated on smokeless fuels; gas coke is the commonest fuel except for those gravity-feed boilers which require a special grade of anthracite. It is, however, possible for the larger sectional boilers to be fitted with automatic underfeed stokers using small size bituminous coal, the thermostat controlling both fuel feed and the primary air damper; combustion is nominally smokeless.

In general, boilers of the sectional and gravity-feed types have narrow waterways. If these are used to supply domestic hot-water it is necessary to use an indirect cylinder, though it is always good practice to include an indirect cylinder if the boiler is used for both hot water and central heating.

(*a*) *Small Boilers.*—While small boilers for domestic purposes have existed for a number of years, striking advances in design and construction have taken place since the war. Considerable attention has been paid both to the combustion controls and to amenity factors, particularly to the ease and cleanliness of refuelling and ash removal. There are two main types: those in which the boiler is of horse-shoe form, enclosing the fire on three sides with an openable door on the fourth, and those in which the boiler encloses the fire on all four sides.

In the main the smaller models are of horse-shoe form, while the large models are of closed type. The smallest designs frequently have no insulation, and so give quite a substantial amount of space-heating from their outer surfaces, which should be put to some useful purpose whenever possible. The modern tendency, however, is to enclose the boiler within an insulated, vitreous-enamelled outer jacket.

Control of the rate of burning is effected by a primary air damper, which must be finely adjustable in the nearly-closed zone, and also by a flue damper which, for safety considerations, must have a cut-away of about 10 per cent, so that it cannot be completely closed. A secondary air supply is desirable since the combustion conditions are often favourable to the production of carbon monoxide.

Very recently there has been a substantial increase in the number of boilers of the smaller types—those rated by the manufacturers in the range from 15,000 to 30,000 B.Th.U. per hour for domestic hot water—which are designed to incorporate thermostatic control.

(*b*) *Sectional Boilers.*—The boiler is built up of a front and a back section, together with as many intermediate sections as are necessary for the required output. This is a form of construction which is advantageous both to the manufacturer, since it enables him to make up a wide range of boilers, and to the user, since extensions can be made at comparatively small expense and repairs normally involve the replacement of a single section.

There is usually some form of thermostatic control, commonly a bimetallic element operating through a chain or link mechanism on the primary air damper. The boiler must be well insulated, usually by a lined outer jacket.

(*c*) *Gravity-feed Boilers.*—The automatic gravity-feed boiler is a very convenient arrangement for the private house of average or large size, because of the small demands which its maintenance imposes upon the user. It has a fuel hopper whose capacity is sufficient for at least 24 hours, and may be adequate for two or even three days under low-load conditions. The fuel feeds itself, through a feed tube or restricted throat, into the combustion zone. In some cases combustion takes place on a bottom grate of shaking type. In others, such as that illustrated in Fig. 6, there is no grate. Instead the combustion conditions are designed to favour clinker formation, and the clinker is used to support the fire on the base of the appliance. At intervals of 24 hours or so, the old clinker is removed and the new clinker pulled forward into the supporting position.

There is thermostatic control operating either on the primary air inlet in the natural-draught types, or on the fan in the forced-draught models. The fire is well surrounded by water-ways, and the water-heating efficiency is normally very high, of the order of 80 per cent. The exposed surfaces must be well insulated.

Gravity-feed boilers are markedly critical with regard to their fuel, and the recommendations of the individual manufacturer must be closely followed. Normally the fuel is a small, graded anthracite, of bean, pea or grain size. There are one or two models designed to burn coke, but these need to be of larger overall size owing to the lower bulk density of this fuel.

Appliances for Gas

The use of gas for space-heating in the home is still on a comparatively small scale, in comparison with its use for cooking and water-heating and is mainly confined to mild weather and intermittent heating in individual rooms. Considerable efforts have, however, been devoted in recent years by the Gas Council and by the appliance manufacturers to improve the thermal efficiency of gas heaters.

Radiant Fires.—The modern trend in design is towards non-aerated burners, although some aerated types are still to be found. The old form of columnar or block radiant has largely been replaced by structures of greater mechanical strength. These commonly take the form of horizontal or vertical bars or rods, in front of a refractory fireback which is responsible for the greater part of their radiation. The range of control of output has been considerably increased, with comparatively little variation in radiant efficiency over the whole range.

Radiant fires are available in both fixed and portable forms, to stand in a conventional fireplace and discharge the combustion gases up the chimney. A panel form, primarily intended for bedrooms, is fitted into a prepared recess in the front surface of the flue.

There is also a combined coke and gas fire, which is a conventional inset coke-burning grate with a small radiant gas fire mounted on its front, with a hinged cover. The gas fire can then be used in place of the main coke fire in mild weather, or to give supplementary heating when desired.

Convector Fires.—While the principle has been known for many years, it is only comparatively recently that serious attention has been paid to the development of this inherently more efficient type of fire. Ducts or channels are provided behind the refractory radiating back of the fire, and ducts are led through the hot combustion gases as far as spatial limitations will permit. Air is drawn through these ducts or channels by natural convection, warmed, and discharged from a top outlet. One model is illustrated in principle, and in finished appearance, in Fig. 7.

Flueless Heaters.—These are intended mainly for background heating in circulation spaces and in rooms. In the latter case it is necessary that there should be adequate means of ventilation. Portable models, of both radiant and convective types, are available as well as larger fixed designs which are usually convective.

Balanced Flue Heaters.—This type has only been used, as yet, on a very limited scale for domestic purposes, but it has the virtue that a conventional flue system is not required. The heating is mainly by convection, the heater body being isolated from the room. Ducts through the wall convey combustion air to, and combustion gases from, the burner and are so disposed on the outside that wind pressure effects are largely balanced.

Central Heating Boilers.—Various types of gas-

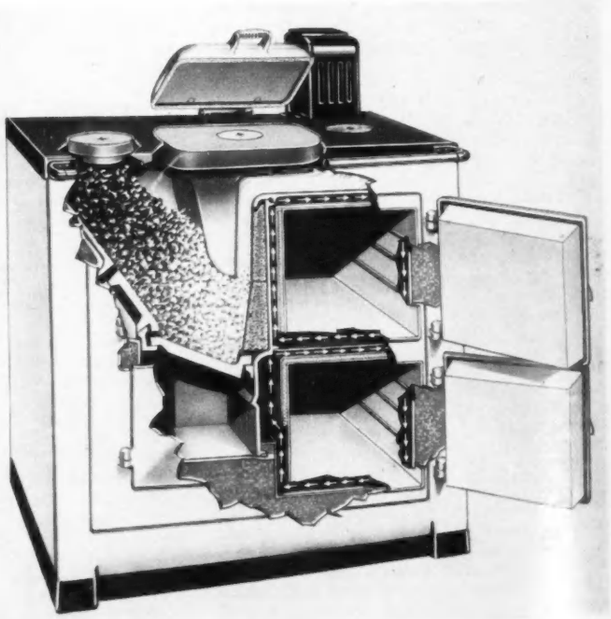

Fig. 5 Heat-storage solid-fuel cooker (Smith and Wellstood, Ltd.).

* Chief Physicist, Fuel Research Station, Department of Scientific and Industrial Research.

† *Reprints of the whole article are available, price 2s. 6d. post free, from the Publisher, ENGINEERING, 35-36 Bedford-street, Strand, London, W.C.2.*

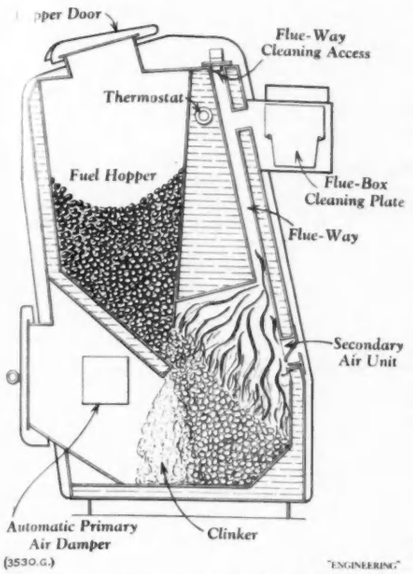

Fig. 6 Gravity-feed anthracite boiler (Janitor Boiler, Ltd.).

fired boiler, including sectional boilers, are available to cover the range of heating requirements covered by this review, and sectional-type solid-fuel boilers can be converted to gas burning. The higher running cost associated with gas is off-set to some extent by the absence of need for any form of fuel storage, and by the simplicity of the thermostatic control system. It is usual to use luminous burners, and to operate on a high-flame/low-flame cycle.

It is essential to make the gases pass over a baffle before entering the flue. This admits additional air to the flue, which reduces the danger of condensation, and also prevents down-draughts which might extinguish the flame. It is nevertheless desirable to use asbestos-cement flue pipes and to line chimneys with a fire-tile lining as a protection against condensation corrosion.

Water Heaters.—Gas heaters are most commonly of the instantaneous type, in which water is heated as it passes through the appliance. The flame may either be controlled manually, or lit automatically from a pilot jet when water is flowing. Heaters may be single-point, standing above the sink, bath or basin to be supplied, or multi-point with piped connections to several draw-off points. A wide range of capacities is available to meet various domestic needs. Storage-type heaters are also available.

Continual improvements are being made in materials and in devices to minimise maintenance. The application of the balanced-flue principle, to which reference has been made earlier, has simplified the installation problem.

Cookers.—It is not necessary to make more than a passing reference to gas cookers, which have been marketed in high-quality forms for many years. They are available in a wide range of sizes and types to meet the diversity of needs. Detail improvements are constantly being made, especially from the point of view of user convenience.

Appliances for Electricity

Since the war, consumption statistics show that there has been a marked increase in the amount of electricity used domestically for short-period main heating and for background heating purposes. A wide range of appliances, covering many sizes, types and finishes, has been developed to meet individual requirements and preferences.

The conventional pre-war types of radiant heater, of both firebar and rod types, have assumed modern design forms. There has been a trend towards the greater use of the rod type of heater, usually in association with some form of reflector to concentrate the radiation over a more limited field. Fires incorporating the imitation of a solid-fuel fire continue to be developed.

Perhaps the most notable line of development has been that of low-temperature heaters whose output is mainly or wholly convective in character. Their purpose is to provide background heating, or to supplement some other source of heat. There are two main types. There are liquid-filled radiators, which may be either of column or panel type; the liquid filling is normally oil. They are available at ratings ranging from 0·5 to 3 kW, the majority being about 1·5 to 2 kW. Control may be by thermostat or by manual switching; in the latter case provision is usually incorporated for reducing the output by one or two stages from the full value.

The other type is the more portable form of convection heater, in which the heater element is enclosed and the whole output is given as warm air, usually by natural convection but sometimes with fan assistance. This type is particularly suitable for use where young children are concerned, because of the low surface temperature of the outer casing. The outputs cover much the same range as for the liquid-filled radiators. There is generally provision for two or three-stage switching; thermostatic control is available but less common.

One interesting method of electric heating which may be mentioned is the "Dulrae" system, which consists of insulating paper into which an electric heating wire is woven. The paper is pasted to the ceiling and then covered with ceiling board. The heating wire operates at a very low temperature and warms the room both by low-temperature radiation from the full area of the ceiling and by the air heated in contact with the ceiling.

Storage Heating.—A form of electric heating in which there have been interesting new developments since the war is that of "storage" heating, of which two particular types may be mentioned. Both are associated with the use of electricity at off-peak times, and the availability of specially attractive tariff rates at such times.

The first type is the independent, semi-portable storage heater in the form of a large block of refractory material in which a heating element of up to 1½ kW is embedded, the block being contained in a lagged outer casing. It is claimed that continuity of heating can be obtained with an eight-hour charge provided that the building in which the unit is used has a reasonable thermal capacity. In round terms, one-third of the heat input is dissipated during the night charging period, creating a comfortable environment for the beginning of the next day, while the remaining two-thirds is emitted during the day.

The second form of storage heating is that in which underfloor coils are used, so that the whole structure forms the heat storage unit. This system is at present being used in an eight-storey block of all-electric flats at Kirkcaldy, Fife. Here the cables are run in aluminium housings of U-section which are laid on top of the sound-insulating blanket. The housings are bonded to expanded metal which acts as a heat diffuser and also serves as a reinforcement for the screed floor. Floor heating is provided only in the hall and living room in each flat. Either circuit can be switched off by the tenant at will and, in addition, control is provided through a wall thermostat.

Normally off-peak electricity is available from 7 p.m. to 7 a.m., with a mid-day boost if required. The living room is provided with a 2kW electric radiator, which serves as a focal point of warmth and provides topping-up heat when required.

It is too early yet to remark on the potentialities of either of these schemes in this country, though it may be noted that the block-type heater is used on an extensive scale in Eire. Storage heating is obviously not as flexible as some other types of heating, and its success may well depend upon how attactive the special off-peak tariff can be made. At Kirkcaldy the off-peak rate is stated to be 20 per cent. lower than the normal rate (0·7*d.* per kWh against 0·875*d.*).

The Heat Pump.—The heat pump is, in effect, a refrigerator operating in reverse. It takes heat from a low-grade source such as a river or well, or buried earth coils, and up-grades it to heat at a useful working temperature. A "coefficient of performance" or "up-grading gain" of the order of 3 is commonly obtainable, i.e. 1 unit of heat input yields a gross output of 3 units. For the present purposes it is assumed that the pump will normally be driven by electricity; the principle is, however, unaffected by the fuel used for the prime mover.

The heat pump is used on a fairly extensive scale in both the U.S.A. and in Switzerland. In the U.S.A. there are many areas where the climate makes house-cooling in summer as desirable as house-heating is essential in the winter, and here the ability of the heat pump to be reversed in summer is an undoubted economic attraction. This is not the case in Switzerland, but the electricity there is relatively cheap while other fuels are expensive. In Great Britain, where neither of these special factors is operative, the use of the heat pump has been on an experimental scale only, and there is insufficient evidence for its proper assessment in comparison with other forms of whole-house heating systems.

It is frequently asserted that the high capital cost of the heat pump will preclude its wide use for house heating in this country. It has, however, been pointed out by Sumner[18] in reviewing an experimental installation in his own bungalow, that it is desirable to design and build a house with the heat pump and the thermal insulation as integral parts

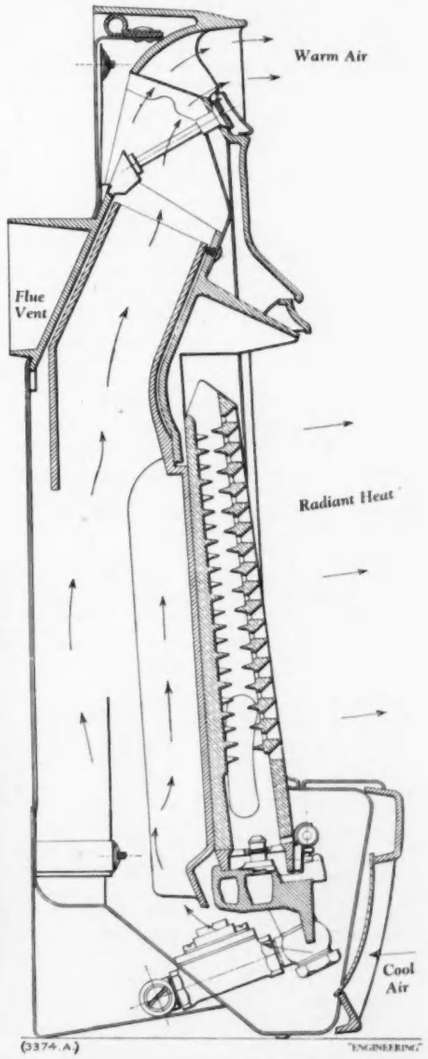

Fig. 7 Convector-type gas fire (Cannon (G.A.) Ltd.). Left, as installed. Right, section showing convected and radiant heat paths.

of the design. When considering capital cost, therefore, it is proper to take the whole building into account, so that credit is given for the capital saving resulting from the elimination of such features as flues and fireplaces.

A simple form of small heat pump for domestic purposes has, however, recently come on the market and has interesting potentialities. There are two models, the "Duotherm"[19] and the "Fridge-Heater,"[20] which have basically similar characteristics. The unit is designed to stand in the larder of the house and extract low-grade heat from it. Thus the larder is kept cool, while the unit itself provides the normal facilities of a 1½ cub. ft. refrigerator. The heat abstracted is supplied as hot water, normally to the extent of about 80 gallons per day; there is a 30 gallon copper cylinder.

Two reactions of the unit, which may affect its effectiveness in particular circumstances, have been noted. The first is that, ultimately, the heat is withdrawn from the room in which the larder is situated, usually the kitchen. Thus unless there is ample waste heat in this room the operation of the heat pump may result in discomfort to the occupant. The second is that the pump needs to be controlled by a thermostat in the hot-water tank. To prevent extensive shut-off periods of the unit, to the possible detriment of its refrigerating commitments, it may be necessary to incorporate some form of permanent heat bleed, such as a towel rail or airing cupboard radiator, in the hot-water circuit.

Water Heaters.—Storage-type heaters are made in two main sizes: 1½ to 3 gallons capacity for sink use, and 20 gallons for the supply to baths. They are thermostatically controlled.

Immersion heaters are installed in existing hot-water storage tanks associated with solid-fuel water supply systems, to give supplementary or summer heating. Normally of 2, 3, or 4 kW rating, they may be either thermostatically or manually controlled.

Cookers.—As with gas cookers, it is unnecessary to do more than make a brief reference to electric cookers. They are made in a wide range of sizes and types, to meet individual needs. Constant improvements, especially in features of convenience to the householder, are being incorporated.

APPLIANCES FOR OIL

Although oil-fired burners have been used in large industrial plants for many years, it is only recently that this type of combustion unit has become both available and in keen demand for the smaller types of boiler, such as are used to supply central heating and domestic hot water in dwelling houses. It is a trend which is developing rapidly and depends largely upon two factors—the availability of quantities of distillate oils at reasonably attractive prices, and a demand from the servantless middle class for heating systems which afford the maximum of cleanliness and convenience in operation. While a few models are coming on the market specifically designed for oil firing, in the main the tendency is towards the production of conversion units to be applied to existing solid-fuel boilers.

The majority of the oil burners to be considered in this section use a light distillate known generally as "gas oil," though it is sometimes marketed under proprietary names such as "domestic fuel oil." It has a gross calorific value of 19,600 B.Th.U. per lb., and a viscosity of about 35 sec. Redwood No. 1 at 100 deg. F. Its pour point is sufficiently low for outside storage, without preheating arrangements, to be practicable in this country. For the smallest types of oil burner, and for the portable space heaters which will be described, kerosine (paraffin) is used.

The type and size of oil storage container chosen depend not only on the capacity of the burner but also on local spatial and economic considerations. For the larger burners an above-ground outdoor storage tank is normal. Various sizes from about 150 gallons upwards are procurable. Where circumstances permit the use of a tank of 600 gallons capacity or upwards, advantage may be taken of the reduced rates for bulk supply which are generally available for quantities of 500 gallons or over. At the other end of the scale some of the smaller burners are supplied with oil containers suitable to stand in the kitchen alongside the boiler itself; their capacities range from 3 gallons for the smallest kerosine vaporising burner to 8 to 10 gallons of gas oil.

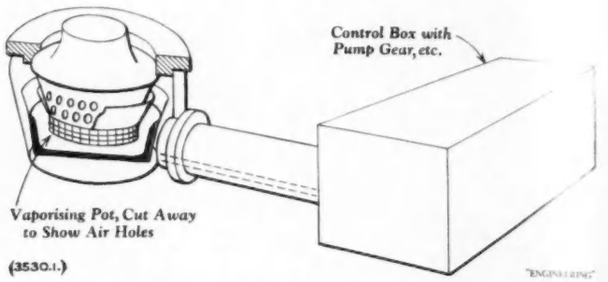

Fig. 9 Pot-type vaporising burner for oil.

Pressure-Jet Burners.—For the larger types of boiler for central heating, covering the range from about 5 to 30 sq. ft. heating surface, it is normal practice to use a fully-automatic pressure-jet burner. While there are many variations in details in different designs the burner consists basically of a swirl chamber, normally conical in form, with the final discharge orifice at the apex of the cone. Oil is fed into the chamber at a pressure of the order of 150 lb. per square inch, through two or more tangential channels. There it rotates about a central air stream and emerges from the orifice as a thin, rapidly rotating column, which spreads and breaks up into a cloud of tiny droplets. Fig. 8 shows the main features of a burner of this general type.

Pressure-jet burners are normally made fully automatic, with electric ignition by spark from a transformer. Control is exercised on the ignition, and on the oil and air supplies, through a thermostat, and the burner functions on an "on-off" cycle. In some cases photo-electric or other types of flame-failure device are fitted; alternatively the ignition system may be arranged so that the spark is constantly present during the "on" period. In any event care must be taken that the aerodynamics of the combustion chamber do not favour a "drift" of the flame away from the jet orifice, which will conduce to flame failure.

Solid-fuel boilers are designed for heat transfer mainly by direct conduction and by flame radiation from the burning fuel, through the primary heating surface. The oil burner, on the other hand, depends to a greater extent on heat transfer from the hot combustion gases. Where the boiler to be converted to oil-firing is one which does not incorporate much secondary heating surface, it may be desirable to consider the addition of some form of economiser in the flue adjacent to the boiler.

Vaporising Burners.—For the smaller types of boiler, below about 5 sq. ft. heating surface, the pot-type vaporising burner has become very popular. It is available in both forced-draught and natural-draught models. In the forced-draught form, of which Fig. 9 illustrates in diagrammatic manner one design, oil is fed to the vaporising pot through a constant-level chamber with overflow safety device. A jet of air is blown rapidly over the surface of the oil in the pot, so that it is vaporised. It is manually lit and thereafter is normally controlled automatically on a high-flame/low-flame cycle by a thermostat operating on a needle valve in the oil-feed line.

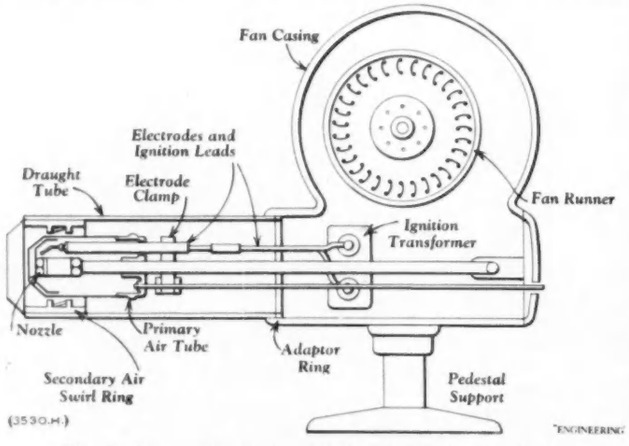

Fig. 8 Pressure-jet oil burner (British Oil Burners, Ltd.).

The simplest form of vaporising burner is the natural-draught type, burning kerosine, for use in the smallest boilers. It is lit manually and the rate of burning is normally controlled manually and not automatically. It is generally desirable for some form of draught stabilisation to be incorporated in the flue.

Room Heaters.—There has recently been a marked increase in the availability and popularity of portable kerosine-burning space heaters, mainly intended for the warming of halls and other circulation spaces in the home, and for supplementary heating in living rooms. They are mainly of the blue-flame type, and should be used with the premium grades of oil now available, which are low in sulphur and remarkably free from combustion smells. They may then be used for quite long periods without discomfort, provided that the ventilation is adequate to keep the concentration of products of combustion low. The modern kerosine-burning heaters are mainly of the convector type, with an enclosed flame and a sheet-metal outer casing through which air is drawn and heated, but some are of the radiant type, often with a metal reflector to concentrate the radiant beam.

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STOPPING VAPOUR LOSS IN OIL STORAGE TANKS

Rubber "Tyre" 80 ft. in diameter

A new method of eliminating vapour loss in large petroleum storage tanks has been incorporated in two tanks each 80 ft. in diameter by 36 ft. high, recently completed for the Mobil Oil Company's refinery at Coryton, Essex, by Wm. Neill and Son (St. Helens) Ltd., St. Helens, Lancashire, and Victoria Street, London, S.W.1.

These two tanks, which each hold over 1,000,000 gallons of petroleum product, have twin-skin steel floating roofs which float up and down on the surface of the liquid stored. Between the floating roof and the tank wall is fitted an 80 ft. diameter "tyre" made of nylon fabric base, coated on each side with butadiene acrylonitrile synthetic rubber. This tyre is partly inflated with liquid and secured to the floating roof of the tank, thereby preventing vapour from forming, and acting as a complete seal between the floating roof and the wall of the tank at all times. The rubber tube, which is protected with a similar synthetic rubber scuff band, rises and falls with the level of petroleum product, carrying the steel roof with it.

This new method of sealing hydro-carbon products is the first of its kind in Europe and has aroused considerable interest in the petroleum industry. It is built under licence from the Hammond Iron Works, U.S.A.

The Engineering Outlook—10

DILEMMA IN THE MOTOR INDUSTRY

CONFLICTING DEMANDS OF BUYERS

It is now more than a year since the motor car industry published, in a series of announcements from the big companies, its long-term expansion programme for the next five years. Last year's article in this series dealt to a large extent with the reasons which had prompted the industry to undertake this expansion plan which will raise the capacity of the motor-car industry from 1 million vehicles in 1954 to 1,500,000 in 1960, of which 200,000 a year will be cars destined for the home market. It was expected, in fact, that exports, which totalled jut over 300,000 in 1954, would rise by as much as another 150,000 cars a year. Events since the plans were published in the spring of 1955, make it inevitable that this article should deal mainly with the effect of current economic events on the industry's long-term expansion programme.

MARKET PROSPECTS

It will be recalled that the impelling force behind the expansion programme was two-fold. On the one hand, there was a feeling within the industry that if mass production of the cheaper cars could reduce prices significantly there was an untapped market for cars within this country that would support a considerably larger motor-car industry. From this, there would follow significant economies which would enable prices to be cut in the export market. On the other hand, the industry is faced with the constant pressure of rising costs in a period of inflation. About 60 per cent. of the ex-works cost of a car consists of bought-in components (though the percentage varies a good deal from one company to another). The industry can argue that although it has comparatively little control over the trend of its external costs, it does have control of its internal costs—except for wages. If the capital investment per worker were increased, with resultant decline in labour costs per unit of output its control over total costs would be correspondingly increased.

Those who criticised the industry's plans in 1955, did so on the grounds that the country could not afford either the heavy investment in capital equipment which the industry proposed to make, or the large modernisation programme which would be required on the roads if a further 350,000 vehicles a year were to use them. (This 350,000 would consist of 200,000 cars and 150,000 commercial vehicles). It was also said that that there would be a shortage of labour and of machine tools which would further impede expansion, even if the idea was basically sound. Thus criticism was based mainly on the large share of the country's annual capital investment programme which would be allocated to the motor-car industry. In the event, these arguments had little effect on the industry's plans and expansion went ahead.

In 1956, the basic reasons for expanding the motor-car industry are just as valid—no more and no less—as they were in 1955. The big change which has occurred in the last year is the economic environment in which the industry has had to operate. Motor-car manufacturers have suffered two severe blows in the last 12 months. First, although no direct prohibition has been imposed on their expansion programmes, they have been subjected to marked indirect pressure through the credit squeeze and the further limitation of hire-purchase facilities. In the export market, they lost, for the time being at any rate, part of the Australian and New Zealand car market, thereby depriving them of sales at the rate of about 30,000 a year at the present time. The industry is thus obliged to justify its expansion programme increasingly on its long-term faith in the expansion of the home market and the increased competitive power to export which it will gain from this situation owing to the expected fall in average costs of production.

On the cost side there is no doubt that the car manufacturers' fears that they would be subject to increasing pressure from external costs have been justified. A feature of the accounts of the chief companies for their latest financial years, covering in most cases, where these have been recently published, their trading experience in the calendar year 1955, has been the very satisfactory output figures accompanied by a drop in profit margins.

The questions left for debate are therefore the behaviour of the home market and the severity of competition abroad. The industry has been attracted by the possibility of tapping a new market with a cheap car—and this means cheap to buy and cheap to run. Is this argument as sound as it seemed a year ago? It is not an easy question to answer. If it were, the industry would be a good deal less perplexed than it is at the moment.

PROBLEMS AT HOME

The difficulty about assuming that sales will increase if prices are reduced is putting a figure to the increase. Fairly accurate estimates can be made about staple foodstuffs and the like but it is much more difficult to make sound estimates in the case of consumer durable goods. It is beginning to look as if the home market for cars is going to be a good deal more fickle than had been expected even 12 months ago. There are two reasons for this. First, if monetary policy is used for controlling inflation it is as certain as these things can ever be that consumer durable goods will take the main impact of change. A Government which uses the bank rate and ancillary devices to influence the economy will almost certainly make the effect felt more quickly on personal incomes. This even applies when there is talk about limiting bank advances, for the first sufferers are personal and professional overdraft facilities. Second, the impact of such controls on personal spending will affect those industries where personal decision as opposed to the decision of companies and public authorities in the matter of purchase is most pronounced. This has now become a critical point for the motor-car industry. Even five years ago it was thought that about 80 to 90 per cent. of cars bought were purchased by companies and other corporate bodies. The recent trend of car sales suggest that this percentage has dropped rather more quickly than had been thought.

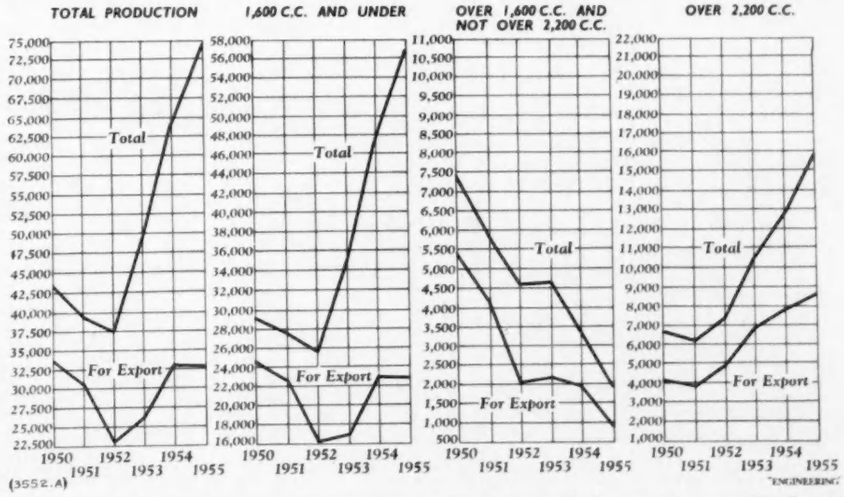
In other words, the domestic car market may be much more subject to fluctuations in personal incomes and spending habits than was expected. The proportion of total sales represented by companies and other organisations supplying their executives and staff with cars may be lower than was thought to be the case when the industry's expansion plans were formulated. It does not need a large drop in this percentage to bring about a serious change in the trend of car sales in the home market. This being so, the home market may prove to be somewhat less stable than looked likely even a year ago.

If this should be true, the argument for expanding the industry to concentrate on mass-produced cars, apart from the specialist car makers who are in a category of their own, still depends on the likelihood of a long-term expansion in ownership to be brought about by cars of lower initial cost and lower running costs appealing to the lower income brackets. Within this expansion, however, there may be short-period fluctuations induced either by the Government policy of trying to force cars away from the home market into the export market or by serious cyclical changes in demand due to variations in the public's purchasing power which are not due to Government action but to influences, such as the balance of payments, which may get beyond its control. In either event, the car industry may be heading for greater capital investment and greater fluctuations of demand—not a happy combination for the short-term profitability of the industry.

OVERSEA CUSTOMERS

As to the severity of competition, there is no doubt that this is increasing. The accompanying Table shows that the export of cars in 1955 was slightly higher in value than in 1954. The full impact of the Australian import cuts had not been felt, however, up to the time. Indeed, during 1955, exports to Australia at £16·8 million were 10 per cent. higher in value than in the year before. The slight advance in the value of exports in 1955 also hides the fact that, though the United Kingdom's share of motor-vehicle exports continues to grow, its share in total world exports has fallen sharply since 1953 to the advantage of the United States and Western Germany. If motor-car exports for the first two months of 1956 are considered, the figures look even less reassuring.

The value of exports of new cars in January and February, 1956, was £17·9 million compared with £22·7 in the same period of 1955. To some extent the drop may be accounted for by the



Output in the United Kingdom of the principal sizes of motor cars during recent years. The figures are given as monthly averages for the year concerned.

TABLE.—United Kingdom: Exports of New Vehicles, Chassis and Parts (Value: £1,000)

—	Cars		Commercial vehicles		Total	
	1954	1955	1954	1955	1954	1955
Complete vehicles and chassis—						
Union of South Africa	5,162	8,257	5,283	7,445	10,445	15,702
Southern Rhodesia	1,882	4,234*	1,367	2,663*	3,249	6,897*
Australia	24,307	26,172	10,358	13,352	34,665	39,524
New Zealand	12,768	12,499	3,957	4,843	16,725	17,342
Canada	5,738	5,264	304	560	6,042	5,824
Other Commonwealth countries	13,630	17,776	19,169	23,068	32,799	40,844
Irish Republic	4,931	5,645	2,130	2,448	7,061	8,093
Sweden	12,699	6,108	1,125	635	13,824	6,743
Denmark	3,904	2,190	2,464	1,509	6,368	3,699
Netherlands	3,680	3,836	1,954	2,732	5,634	6,568
Belgium	4,058	4,369	1,895	2,010	5,953	6,379
U.S.A.	11,165	9,205	92	497	11,257	9,702
Other foreign countries	14,595	16,910	17,958	24,066	32,553	40,976
Total	118,519	122,465	68,056	85,828	186,575	208,293
Parts	—	—	—	—	51,102	48,983
Grand Total	—	—	—	—	237,677	257,276

* Rhodesia and Nyasaland.

particularly severe freeze-up of European ports this winter (though the winter of 1954-55 was severe enough), but the President of the Board of Trade said in the House of Commons in March that the figures were affected by competition from Western Germany in European markets and by the Australian import restrictions. Increasing competition, notably in the Swedish market, has been building up for a long time. Indeed, in the first nine months of 1955 German exports to the rest of Europe increased by 46 per cent. in numbers to 189,000, while British exports to the same area dropped by 15 per cent. to 81,000 cars. The United States, France and Germany were all increasing their exports substantially to the European market over this period. German competition is making serious in-roads into the United States and Australia. Volkswagen took over a Studebaker factory in New Jersey in 1955 and has scheduled a large expansion in output from it for 1956. In Australia, where the United Kingdom has been consolidating its position despite the import restrictions, the German challenge is growing and will grow further when the import restrictions are eased.

It is apparent that the brunt of the export war is being taken by the small cars with an economical performance. It is being fought out at present by Austin, Morris, the smaller Ford models and Hillman, against Renault, Citroen, Fiat and Volkswagen. The graphs in Fig. 1, page 273, bring out the effect of competition in the export market for cars of 1,600 c.c. and under. In recent years the bulk of production and exports of cars has been in this category.

Output and exports have shown until 1955 an encouraging upward movement since the recession of 1952. The 1955 figures indicate, however, that the upward progression has been arrested. In consequence, the only group which continued to show an upward movement in exports last year was the over-2,200 c.c. class, which includes the specialist models. These have had outstanding success in export markets since they were forced abroad in the "export or die" injunction at the time of more stringent steel allocations some years ago.

SAFE-GUARDING PRODUCTION

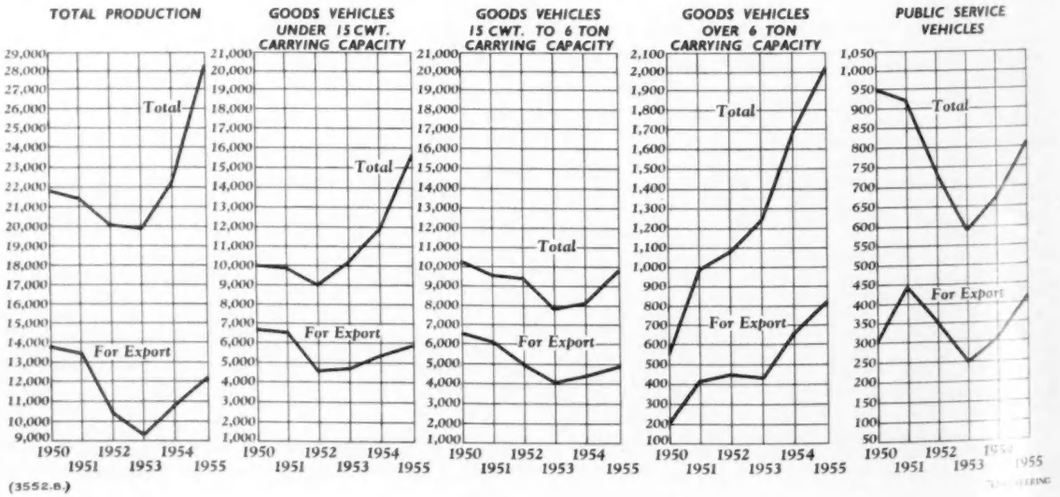
It is not going to be easy for the motor-car industry to reconcile short-term and long-term policy. Manufacturers seem likely at the moment to keep to their long-term programme of expansion on the assumption that they can control their costs and bring down their export prices with the help of a long-term expansion in the home market. There seems every likelihood, however, that in 1956, to look no further, the industry will have to carry out its long-term plans against the obstacle of the Government's monetary policy. This is bound to lead to temporary shifts of policy. There are already indications of the complexities which may develop if this conflict between the industry's policy and Government deflationary policy persists too long. Some makers have raised their prices in the home market, presumably on the assumption that home demand is being cramped by the Government policy of increasing hire-purchase restrictions and that the home market is therefore becoming somewhat more inelastic and prepared to pay a little more for the same article. Although this policy can be justified on certain assumptions, it is not a move in the direction of cheaper cars in the domestic market—quite the reverse. For some manufacturers there is the possibility of temporarily switching resources from cars to agricultural tractors—a move which may attain some success should the modification of the Chinese embargo on tractors already announced go further. While improvisations of this go on there is always the possibility of change in the appearance of the more popular British cars. There has been a great deal of criticism about the stagnation of British design recently and the time must come fairly soon now, especially for those companies which are erecting new buildings, when a decision will have to be taken as to how far re-tooling must go to meet the bolder designs which foreign competitors are selling in oversea markets.

COMMERCIAL VEHICLES EXPAND

For the first time in recent years, 1955 saw a larger increase in the value of the deliveries of commercial vehicles than of private cars. Average monthly deliveries of commercial vehicles at £19·5 million were 25 per cent. up on 1954 while car production at £29·7 million increased by only 17 per cent. Average monthly exports at just over 12,100 vehicles were 12 per cent. up on the year but they were still some distance below the level achieved in 1950. There was a 32 per cent. increase in the production of light commercial vehicles, while the medium and heavy categories recorded 20 and 19 per cent. increases, respectively.

Measured by value, exports of commercial vehicles in 1955 were about 26 per cent. above the level for 1954. The export of chassis is a very important side of the export trade, but in 1955 the export of complete commercial vehicles increased rather more than chassis exports. At £37·4 million, exports of complete vehicles were 35 per cent. up on the year, while chassis exports at £48·4 million were up 20 per cent. A large proportion of the expansion is completed commercial vehicle exports last year, however, was to Australia and New Zealand but these particular sales will have suffered a set-back in the current year.

One of the phenomenal increases in 1955 was the expansion of exports of chassis to Finland, which increased from £0·6 million to £2·0 million. On the other hand, there was a decided fall in sales to the rest of Scandinavia, re-echoing the recent experience of the motor-car trade. In South America there was a big improvement in exports of chassis to Argentina, but it was offset by a corresponding drop in the value of finished-vehicles exported. Much of the improvement, however, over foreign markets as a whole, has been in small vehicles, including station wagons and estate cars. Among complete vehicles, those exceeding 3 tons unladen weight suffered a slight set-back and there was little change in the value of coaches and omnibuses exported. Among chassis, however, there was a big increase in the shipment of un-assembled vehicles, the total rising from £7·7 in 1954 to £13·2 million in 1955. There was comparatively little change among chassis exports of coaches and omnibuses.



United Kingdom output of commercial vehicles, shown here as monthly averages for each of the years concerned.

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MINING RESEARCH

STEPS TOWARDS THE AUTOMATIC COAL MINE

Like all other industries, coal mining involves a certain amount of research, and to carry this out the National Coal Board set up, in 1952, the Mining Research Establishment at Isleworth, Middlesex. The work carried out in these premises continues and extends that which had been previously undertaken on a small scale in the Central Research Establishment at Stoke Orchard. Dr. L. C. Tyte, C.B.E., has held the directorship since April, 1953. The work includes investigations into the breakage of coal, rock drilling by rotary and rotary percussive methods and, in conjunction particularly with the latter, metallurgical investigations in the use of cemented-carbide tipped drills.

The study of coal ploughs has led to the development of improvements to existing ploughs of Continental manufacture, which have not been suitable for the rather hard coals met with in this country. The various forces involved in the cutting of the coal with a plough are being investigated and a prototype plough with an automatic percussion attachment has been developed. Percussion comes into play automatically when the force exerted by the blade on the coal exceeds a certain figure, and thereby the loads on the draw-chains are kept down.

The method used is to mount the blade of the plough on very stiff springs which, when compressed by the load, allow the blade to move backwards and operate a pilot valve which, in turn, controls a pneumatic hammer. As soon as the excessive load on the blade is removed (by the piece of coal breaking away) the hammer operation ceases. In this way the advantages of direct ploughing and continuous percussion are combined, and the excessive power for either method used alone is avoided. The present design aims at a 4 in. deep cut which has been found to be the most economical for the coals investigated. A plough embodying these features has been installed in Warsop Colliery and is illustrated in Fig. 1.

Another development is the walking prop which has been produced in conjunction with the Dowty Mining Equipment Company. As can be seen from the illustration, Fig. 2, it consists of a pair of roof supports which have a flexible joint in them and are both mounted on three hydraulic jacks standing on a solid foot. Between the pair is a horizontal hydraulic jack to give relative movement. As the coal face is cut back, one section of the support is lowered on the jacks, forced forward by the horizontal jack and then raised again to take the load while the other member repeats the process until the two are again level.

It is envisaged that with the use of these walking props and with a coal plough running along the side of a conveyor, automatic mining will become a possibility as the operation of the jacks can be made to follow the passage of the plough and the movement forward of the supports would push the conveyor belt, and therefore the plough, forward after each stroke. Such operation would be very suitable for coal seams of 2 ft. 2 in. depth which can be cut in a single passage of the plough, and are very difficult to work by hand.

Work on strata control has also included the development of a load cell to fit between the pit prop and the roof bar, which will give a measure of the force acting downwards from the roof. Plugs fitted with strain gauges have also been developed for advancing into the formation ahead of the working face to show the stresses that are being set up as work proceeds. Horizontal boreholes up to 200 ft. long are being planned into which these strain-gauge plugs would be inserted.

For the corresponding investigation into the "pack" behaviour, that is to say in the part of the workings which have been cleared of coal and filled with waste, a dynamometer with a hydraulic transmitting system has been developed which can be mounted in the built-up portions to give a guide to the stresses occurring.

One section of the establishment is devoted to what is called environmental research, covering such items as the presence of dust or gases and heat and humidity. Investigations on these have shown that dust of inspirable size is more likely to be produced by scroll-type rotary drills, particularly when operating at low rates of penetration. Water sprays have some effect in laying the dust. For the presence of gases, methane recorders have been developed which will operate continuously for as long as a week and can be fitted with alarms to give warning when dangerous concentrations occur. Experiments are being made in a Kentish colliery of providing refrigerated air at the working face to keep the temperature low. For heat measurement heat flow discs have veen attached to the walls.

In the instrument branch two types of dust sampler have been constructed, one of which is intended to be left in a return airway or at the coal face, and will collect a dust sample during the entire working shift; the other is for spot-checks on dust concentration. In the first type the air is drawn in by a simple diaphragm pump driven by a clockwork mechanism at the rate of 2 cc. inhaled in one half minute and exhaled in the following half minute. A horizontal elutriator, taking the place of the human nose, extracts the unrespirable fraction of the dust and the remainder is collected on a microscope slide; the quantity obtained can be evaluated by any of the standard methods. One of the instruments is illustrated in Fig. 3.

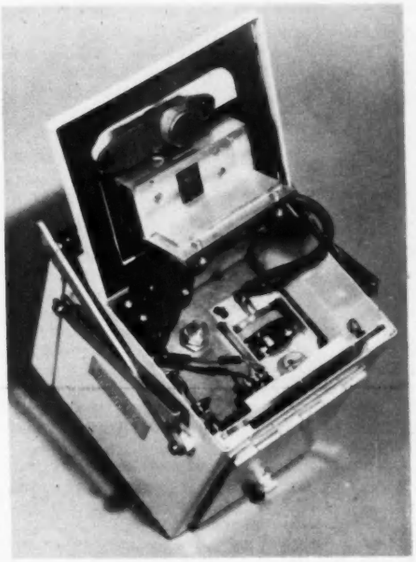


Fig. 3 Special instruments have been developed to collect the respirable dust present in the air at the coal face or in the roads. The one shown is designed to run for a complete working shift.

The spot-check instrument is similar in that it operates by thermal precipitation and contains an artificial "nose" but air is drawn in at the rate of 25 cc. in five minutes, and eight or ten samples can be collected on a microscope slide without having to re-load the instrument. The clockwork mechanism can also be set to give a double sample of 50 cc. in ten minutes. The pump consists of an expanding metal bellows controlled by a timing mechanism.

To enable differences in pressure to be measured accurately, a micro-manometer has been designed to cover a working range of 2 in. water gauge in steps of 0·0001 in. It is basically a Simmons instrument but has had a revolution counter fitted to it and is geared to the mechanism which raises the movable leg of the U-tube. Each digit of the unit wheel of the counter represents a movement of 0·0001 in. The use of the counter removes the difficulty of reading a Vernier in underground conditions. The meniscus is magnified and projected on to the screen.

Fig. 1 The gaining of coal by a plough can be improved if percussion is used whenever the blade meets a hard spot. One plough, of the type illustrated above, has been installed in Warsop Colliery.

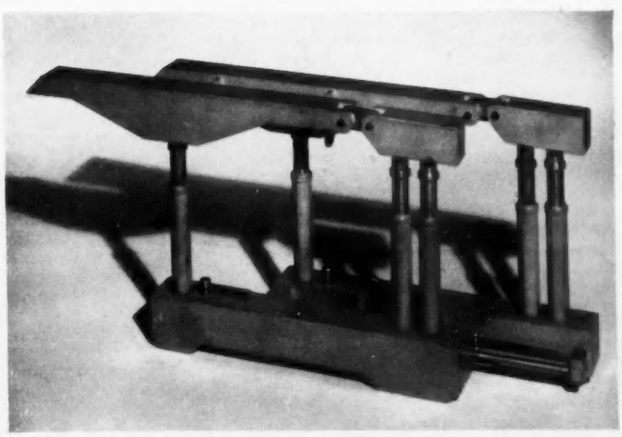


Fig. 2 A model of a walking pit-prop which is operated by hydraulic jacks. Used in conjunction with a plough and conveyor, it could be made to advance automatically as the coal is removed.

Book Reviews

THE DATA BARRIER

Gas Turbine—Vol. 1. Cycles and Performance Estimation. By JAMES HODGE, M.A. (Cantab.), M.I.Mech.E., A.F.R.Ae.S., Member A.S.M.E. **Vol. 2. Some Fundamentals of Combustion.** By D. B. SPALDING, M.A., Ph.D., A.M.I.Mech.E. *Butterworths Publications Limited, 88 Kingsway, London, W.C.2.* (Vol. 1, 50*s.*; Vol. 2, 40*s.*)

Engineering design tends increasingly to become a problem in mathematics: the search for an optimum value of an expression containing many variables. To-day, the designer has so many factors to consider, so many conflicting demands to reconcile, that unless he can state his problems mathematically he will be hard pressed to solve them. Eventually even mathematics may prove an inadequate tool, and progress may be seriously impeded by data which are so complex as to be unmanageable.

Meanwhile, the importance of condensing and assimilating the available information is paramount. Mr. Hodge's book on gas-turbine cycles and performance estimation, which is the first of a series of eight on the gas turbine by various authors, is an excellent example of a design primer, treating comprehensively and concisely a particular sector of the subject. The author, who has served as visiting professor of mechanical engineering at Columbia University, U.S.A., is now head of the consultancy department of Power Jets (Research and Development) Limited and has been associated with gas-turbine development since 1941; he is thus well qualified both theoretically and as a practising designer to view the entire subject and to extract the essential principles. He is also able as editor of the series to maintain a just balance between the aspects treated in different volumes.

The author describes the gas turbine as a prime mover having continuous flow of the working fluid, which remains in the gaseous phase throughout. Thus the air-cycle refrigerator is included but not turbine compounded reciprocating engines, steam turbines and the pulse-jet; the ram-jet is also omitted since it has no turbine or compressor component. Within these limits the book covers installations for aircraft and marine propulsion, vehicle traction, power generation and a variety of auxiliary applications.

In choosing a suitable engine for any purpose it is necessary to make a performance estimate. This would be carried out in two stages: first, a calculation of cycle performance, enabling different cycles to be compared thermodynamically; and second, a part-load performance estimate for a particular turbine plant operating outside its design conditions. These two kinds of calculation are quite distinct and the book is accordingly divided into a major initial section on cycle analysis and a second smaller section dealing with part-load performance calculations. There is a further division in that aircraft turbines are treated separately; this is justified since aircraft-turbine designers are concerned rather with output for a given engine weight and size than with efficiency, which in other installations is usually the main consideration. The book provides all the essential information for these calculations, most of which is in graphical form, and typical estimations are carried out in detail.

One of the author's main objects has been to reduce both data and calculations to manageable dimensions. This is a formidable task since not only are the physical data for the working fluid and the characteristics of turbine components very complex, but there is also an almost unlimited number of different component arrangements. Even for a simple cycle consisting of compressor, turbine and combustion chamber, with no more than two compressor rotors, about 40 layouts are possible; thus with heat exchangers, intercoolers and reheat the range is enormous. (Some important arrangements reproduced from the book are shown in the accompanying diagram.) To complicate matters further, a number of different calculation procedures are possible and the author compares methods of determining cycle performance based on the entropy function, constant but different specific heats for compression and expansion, and true mean specific heats for each stage of the cycle, showing the first to be the most accurate. Reference is also made to methods involving the use of gas tables and the total-heat/air-ratio diagram.

Thus, to simplify calculation various assumptions must be made and principles formulated. To illustrate the kind of assumption commonly employed in cycle estimations it might be taken that the specific heat of the incoming air was equal to that of the combustion products, but this, though sometimes useful, would give rise to considerable inaccuracy.

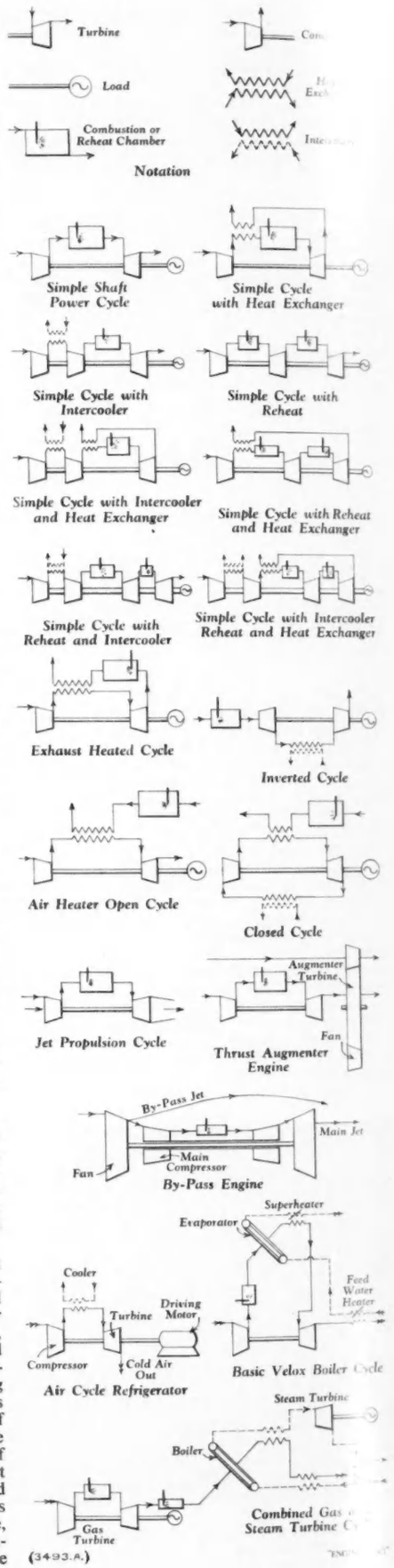
Similarly, a valid approach to part-load calculations must be found. Four main rules are fundamental: mass flow rates through all components in series must be constant; the rotational speeds of components on one shaft must be the same; pressures and temperatures must be compatible throughout the cycle; and in steady operation the powers produced and absorbed on any shaft must be in balance.

It is reasonable to suggest, therefore, that in general the best approach is to find a convenient compromise between accuracy and ease of working, to select valid rules of procedure, and to choose quantities that can be measured directly, such as temperature differences, rather than those, such as energy changes, which might appear more logical.

These procedures underline the important part played by mathematics in the design of gas-turbines, which are in fact inherently suited to a mathematical approach. This is true—especially in overall performance estimation—to a much greater extent than in the case of reciprocating engines. Moreover, the development of the gas turbine has specially favoured the use of mathematical and graphical techniques, for owing to its introduction at a time when other prime movers were well advanced, a great deal of progress had to be made with a minimum waste of time and money on prototypes. Thus the process of trial and error had to be carried out quickly and where possible by theoretical investigations rather than by practical experiment. It was in fact a work of revolution rather than evolution, and it is not surprising that the industrial gas turbine should have taken ten years to become a practical proposition. An immense quantity of data had to be assembled and innumerable cycle arrangements assessed and compared; components had to be designed and their characteristics investigated.

The calculations which Mr. Hodge has outlined show how this vast quantity of material can be assimilated in terms of mathematical processes to give a useful result. But progress is necessarily slow and as technical development proceeds the problem of handling increasingly complex information will provide designers with a more and more serious obstacle—the data barrier.

Fortunately we have to-day a tool which can penetrate, or at least push forward, this barrier—the automatic computer. Already at the Royal Aircraft Establishment the analogue computer TRIDAC (see ENGINEERING, vol. 178, page 596, 1954) is used to predict the behaviour of guided weapons with complicated control characteristics, travelling on irregular paths, in varying conditions; by this means many missile designs can be tested without the expense and waste of prototype construction. In the same way the analogue or simulator computer might also be of service to the gas-turbine designer. As distinct from the digital computer, which is a generalised mathematical tool, the analogue computer is virtually a working model of the real machine, and can be adjusted for various design conditions. Superficially at least, the gas-turbine



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would seem well adapted to this approach; it has continuity of flow and therefore might conveniently be represented by either hydraulic or electrical analogues; it consists of some six components which can be arranged in different sequences—an electrical circuit too can be connected in various ways; calculation, particularly for off-design operation, involves iterative trial-and-error methods—laborious procedures of this kind are minimised by computer techniques.

Many practical reasons may oppose such a development, perhaps in any case gas turbines are already so advanced, their myriad possible combinations so thoroughly investigated and compared, that little purpose would be served by a computer. However, the publication of Mr. Hodge's book would suggest that the essential data and principles have only recently been assembled, so that the real development of the gas turbine has yet to be undertaken. It is of interest to note that the problem of designing such a computer would correspond to the writing of the book under review, both processes being an interpretation or coding of the available information and procedures.

Possibly, however, it will not be the data barrier but some innate feature of the gas turbine itself that hinders progress: the restriction imposed on off-design operation by the compressor surge line, the problems encountered in the use of heavy oils or coal as fuels, or the absence of materials capable of withstanding high temperatures. Incidentally, in the closed cycle it is the heat exchanger that is likely to provide the temperature limitation not the moving parts, since, unlike the turbine blading it cannot by its nature be cooled. The heat exchanger presents another problem, that of size; thus the development of a gas turbine suitable for road traction depends at present on the production of a convenient regenerator. But, as Mr. Hodge makes clear, such difficulties are by no means insuperable.

Consequently, in spite of the author's lucid treatment of mathematical procedures, it may ultimately prove to be the superhuman task of computation that provides the stumbling block, not the technical hazards. This may also be true in other fields of engineering; the pace of discovery in nuclear science, for example, presents the reactor engineer with data he may find increasingly difficult to apply. It follows that, in the future, not only are automatic techniques likely to play a growing part in production processes, but they may also be the means to a new concept of design.

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Mr. Hodge's book on cycle thermodynamics and calculations is intended to form a background to the more detailed consideration of turbine components which will be covered in the other volumes of the series. The remaining seven volumes will be devoted to the following subjects: axial compressors, axial turbines, radial-flow turbo-machines, mechanical construction, heat exchangers and combustion problems. This last topic is dealt with in volume two of the series, which is entitled " Some Fundamentals of Combustion " and has already been published. In writing the book Dr. Spalding has endeavoured to give a coherent picture of combustion theory, embodying the results of recent research, and, although most of the practical applications discussed concern the gas turbine, he has sought to embrace too combustion in boilers, industrial furnaces, rockets, ram-jets and other high-intensity equipment.

The author proposes a systematic method for calculating mass transfer rates in all circumstances, describes some chemical features of combustion and the phenomena of flame propagation, and covers such aspects as laminar flame speed, quenching distance and blow-out velocity. Emphasis is placed on the physical processes of mixing between fuel and oxygen and between burned and unburned gases, and mathematical methods are applied to the prediction of combustion phenomena. Certain of the material has been previously published in ENGINEERING (vol. 177, page 777, 1954).

THE ULCER INDEX

Measurement of Responsibility: A Study of Work, Payment, and Individual Capacity. By DR. ELLIOTT JAQUES. *Tavistock Publications, Limited, 2 Beaumont-street, London, W.1.* (15*s.*)

There is a well-known story about a senior civil servant taking his holiday working on a farm. On the first day he was given the job of digging a patch of garden and went to it with an energy and enthusiasm that astonished the farmer. On the second day he was asked to sort the potatoes by sizes, but when the farmer visited him at mid-day, he had only succeeded in producing two or three miserable little piles. On being asked why he had achieved so little, he could only reply, wiping his brow: " Oh, it's the decisions that I have to make! "

The psychiatrists know that making decisions is the function of the mental system which most quickly causes fatigue and most easily leads to nervous breakdown. Dr. Jaques has applied this knowledge to an inquiry into the nature of work, payment and responsibility and from it has produced a new theory of wages, salaries and differentials. This study is in continuance of his work with colleagues from the Tavistock Institute of Human Relations at the Glacier Metal Co., where he is now employed in a consultant capacity as " social-analyst," and was carried out with the sanction of the company's works council.

Conflicts over appropriate levels of payment for individuals generally revolve around attempts to measure the characteristics of the job—physical conditions, accuracy, complexity, responsibility in terms of numbers controlled or value of work—or the personal qualities of the individual such as skill, training, experience or length of service. All these factors are complex and difficult to measure and lead to irreconcilable disputes. An examination of the tasks performed by persons in the different grades of non-hourly paid employees at Glacier, and later of hourly paid workers, seemed to reveal a logical hierarchy of salaries and wages, both received and expected, in terms of a completely new factor described by Dr. Jaques as the " discretionary content " of work: a factor which was often the least evident feature of a job, especially to an experienced person. In order to discover the extent of the discretionary element, it is necessary first to determine the non-discretionary, or prescribed, element and also the mechanism by which a manager or supervisor reviews his subordinate's use of discretion and so controls the period of time over which the subordinate uses discretion on his own account.

When this was done at Glacier, it was found that people whose work carried the same maximum time-span of discretion, whatever their work, agreed on the same salary, given existing general levels, as being a fair return. The following table is quoted in illustration:

Maximum Time-Span	Earning Expected (April, 1954)
	£ s. d.
One hour	8 0 0 per week
One day	9 0 0 " "
One week	10 10 0 " "
One month	12 10 0 " "
One year	980 " annum
Two years	2,000 " "

When there were individual grievances about salaries, these were associated with payment below the rate ordinarily expected for the time-span at which the member was working. Dissatisfaction could also arise if someone was found to be working at a job below the time-span of discretion of which he was capable.

Although the principle of the time-span of discretion was found to be applicable to hourly rated jobs that carried responsibility of more than a few days it was not easy to do so in shorter-term jobs, although it was felt that more accurate measurement and more precise organisation might change this. Underlying the hourly-rated wage scales there appeared to be a structure dependent upon the amount of wastage that the operator was expected to use his discretion to avoid.

Altogether there was suggested by these findings the notion that a systematic set of principles governing status, grading and earnings was being operated, which was related to the maximum quantity of the firm's resources that were put under the discretionary control of each member and, when payment was not consistent with these principles, dissatisfaction was the result. In the sense here described, work may be defined as a sort of investment behaviour: the bigger the job the longer is the period of uncertainty about the wisdom of the decisions made. A suggestion is even made that wages and salaries may in some way be related to interest at the prevailing rate on the value of resources under discretionary control. What is experienced as size of job, or level of work is, therefore, the experience of the passing of time during which a series of decisions is made and a sequence of actions carried out without the individual being able to know until some time later how good have been the discretion and judgment applied. Weight of responsibility has been translated into time of responsibility, with its long periods of uncertainty. What one gets paid for, in other words, is the degree to which one experiences the psychiatrist's *Angst* or, in popular terms, is liable to develop ulcers.

All this is highly theoretical and Dr. Jaques recognises the criticism that he has assumed a degree of reasonableness in human nature which is rarely experienced when matters of payment for work are being considered. He admits that the possible existence of a theoretical general wage and salary structure offers no panacea for the resolution of these questions, but claims that it does change the framework within which they may be discussed by exposing the real and difficult points of argument more clearly. Whether these ideas can in practice contribute to more reasonable discussion of rewards for different kinds of work remains to be seen; but it would be instructive to see them applied, for instance to doctors, policemen, film stars, bummarees or Members of Parliament.

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Methods of Testing Water Used in Industry. B.S.2690:1956. *British Standards Institution, 2 Park-street, London, W.1.* (17*s.* 6*d.*)

When standard methods for the physical and chemical examination of waters used for steam generation were first proposed, it was suggested that three groups of methods would be required. The first would embody tests which could be made when ordinary laboratory facilities were not available; the second would demand such facilities, together with chemical training on the part of the operator; the third would be intended for research workers. The first method, which is of the widest interest in the field of mechanical engineering, has been embodied in B.S.1427, *Tests for Water Used in Steam Generation.* This new standard, B.S.2690, includes some of the tests of the earlier standard but is of much wider scope and in general calls for chemical training. The third standard, has been deemed unnecessary and has not been prepared. B.S.2690 is divided into sections, each concerned with the testing for some particular impurity such as calcium, silica, chloride, iron, etc.

The nature of the information given may be indicated by reference to the case of iron. It is pointed out that some waters may contain particles of mill scale, or corrosion products in suspension. These should be decanted out; filtration may cause precipitation of soluble iron. If it is desired to include suspended particles in the test, they should be brought into solution. The specification then details two tests, one for waters of very low iron content and the other for higher concentration.

NEW BOOKS

Some of the books noticed here are selected for extended review in ENGINEERING.

Steels for the User. By R. T. ROLFE. Third edition. *Chapman and Hall, Limited*, 37 *Essex-street, London, W.C.2.* (45*s.*)

Some 13 years have elapsed since the publication of the second edition of this work and considerable alterations and additions have been made to the text. Moreover, some illustrations have been removed and others substituted. As was the case with the first two editions, the book deals substantially with carbon steels, but alloy steels are brought in in connection with such processes as nitriding and for high-temperature applications. The aim of the author is to provide detailed guidance on steel quality, heat treatment, case-hardening, fatigue testing and other matters of interest to the user.

Principles and Practice of Radar. By H. E. PENROSE and R. S. H. BOULDING. Fifth edition. *George Newnes, Limited, Tower House, Southampton-street, London, W.C.2.* (50*s.*)

The fifth edition of this very comprehensive text-book, the first edition of which was published as recently as 1949, has been thoroughly revised to keep it abreast of the rapid progress made in this important application of electro-magnetic waves. Some of the earlier chapters of former editions, on basic principles, have been condensed into one, and a chapter dealing with actual equipments has been greatly enlarged. Sections on the latest marine radar sets are now included and one on airfield control radar will be found of particular interest. The revisions throughout this edition have been influenced by the modern tendency to employ still higher frequencies. Sections dealing with micro-wave radar, for instance, have been expanded while references to operation on the longer wavelengths have been curtailed. The chapter on feeder systems has been re-written and in that on duplexing methods special attention has been directed to micro-waves and the problems encountered on those wavelengths. Detailed consideration is given to pulses and pulse-forming circuits, and to the calibration and application of micro-wave technique to transmitters, receivers and feeder-aerial systems. The resonant-cavity magnetron is discussed in the light of present-day knowledge and appendices deal with transmission-line theory, waveguides and cavity resonators. The book contains many illustrations and an index is provided to facilitate reference.

Handbook of Special Librarianship and Information Work. Edited by WILFRED ASHWORTH. *Aslib, 4 Palace-gate, London, W.8.* (50*s.*; 40*s.* to members.)

This handbook has been designed to help both librarians who are called upon to exercise their profession in a particular subject field, and subject specialists who are working as librarians. It is also intended for use by the administrative staff of organisations planning to establish their own information and library services. Aspects of the subject covered include administration; acquisitions; cataloguing and indexing; classification; filing and storing material; binding; library planning; reference and information work; abstracting; and publications of the library and information department. A final chapter is devoted to details of organisations in the special library field.

Plastics Progress, 1955. Papers and Discussions at the British Plastics Convention, 1955. Edited by PHILLIP MORGAN. Published for "British Plastics," by *Iliffe and Sons, Limited, Dorset House, Stamford-street, London, S.E.1.* (50*s.*)

These proceedings include the full texts of the papers presented at the 1955 Convention and the discussions following them. The subjects are as follows:—Polymer structure and properties (3 papers), expanded plastics (2 papers), themoplastics (2 papers), extrusion (1 paper), work study and productivity (2 papers), injection moulding (3 papers), patents (1 paper), foundry resins (1 paper), and glass reinforced plastics (5 papers). Many of the papers are based on original investigations previously unpublished.

Researches into the Welding of Aluminium and its Alloys: A Summary of the Work of the A.D.A. Welding Research Team at the University of Birmingham, 1944 to 1950. Prepared by DR. W. I. PUMPHREY. Research Report No. 27. *The Aluminium Development Association, 33 Grosvenor-street, London, W.1.* (7*s.* 6*d.*)

The Welding Research Team, sponsored by the Aluminium Development Association at the University of Birmingham, was constituted in 1944 to obtain basic data on the factors influencing the welding of aluminium alloys in order to improve the welding of existing alloys and to develop new alloys with good welding characteristics and other satisfactory properties. The present report is divided into seven main sections, namely, cracking at temperatures above the solidus, cracking at temperatures below the solidus, factors affecting weldability, temperature distribution during the welding of aluminium alloys, the development of alloys having good welding and mechanical properties, and cracking diagrams for aluminium alloys.

Hydrogen Peroxide. By WALTER C. SCHUMB, CHARLES N. SATTERFIELD and RALPH L. WENTWORTH. *Reinhold Publishing Corporation, 430 Park-avenue, New York 22, N.Y., U.S.A.* (16.50 dols.) and *Chapman and Hall, Limited, 37 Essex-street, London, W.C.2.* (132*s.*)

The technology of hydrogen peroxide has undergone rapid development in recent years. The large scale use of the concentrated product as a military propellant in Germany during World War II demonstrated that this material could be handled safely in large quantities. Since 1945, the authors have been engaged in research on hydrogen peroxide at the Massachusetts Institute of Technology, and this book was produced to supply the need of a comprehensive source of information on the subject in the English language. The aspects covered include discovery and early work; formation and manufacture; concentration, purification, structural materials and handling; physical and chemical properties; stabilisation; and uses. Subject and name indexes are included.

Handbook of Barrel Finishing. By RALPH ENYEDY. *Reinhold Publishing Corporation, 430 Park-avenue, New York 22, N.Y., U.S.A.*, (7.50 dols.); and *Chapman and Hall, Limited, 37 Essex-street, London*, W.C.2. (60*s.*)

Within the last few years, barrel finishing has been applied to micro-finishes, selective deburring, burnishing, edge-rounding and colouring, and usually proves less costly than other methods of doing the same work. In the first part of the book, the author discusses the layout and equipment used, finishing compounds and media. The main part of the work is devoted to the basic types of finishing methods and the parts for which they are suitable, and largely take the form of tabulated case histories, in which the part to be treated is illustrated and a detailed specification of the treatment is given—barrel type and speed, chip type and load, type and amount of finishing compound, water load, parts per load, and tumble time.

Fluid Mechanics. By R. C. BINDER. Third edition. *Constable and Company, Limited, 10 Orange-street, London, W.C.2.* (45*s.*)

This text-book, which is intended as an introduction to the fundamentals of fluid mechanics, and which lays emphasis on physical concepts, is divided into two parts—Part 1, dealing with basic relations, covers fluid properties, statics, kinematics of fluid flow, dynamic or momentum equation, energy equation for steady flow, viscosity, dimensional analysis and dynamic similarity. Part 2, dealing with applications in fluid mechanics, covers the flow of incompressible fluids in pipes, fluid meters, flow in a curved path, resistance of immersed bodies, dynamic lift, propulsion and craft motion, general features of fluid machines, turbines and fluid couplings, flow of liquids in open channels, compressible flow, compressible flow in pipes with friction, fluid power and control systems, lubrication, unsteady flow and noise. Selected bibliographical references, and problems for students' solution are included at the end of each chapter, with numerical solutions at the end of the book.

Kempe's Engineer's Year-Book for 1956. Edited by C. E. PROCKTER under the direction of B. W. PENDRED. 61st edition. In two volumes. *Morgan Brothers (Publishers), Limited, 28 Essex-street, London, W.C.2.* (75*s.*)

The 1956 edition of Kempe's Engineer's Year Book, which provides data on practically all branches of engineering and engineering materials, metallic and non-metallic, contains the following changes as compared with the 1955 edition: an entirely new chapter on "Foundations and Earthwork" replaces the former chapter on "Earthwork," and includes details of earthwork plant. The chapters on "Aerodynamics" and "Aircraft Propulsion" have been re-written and enlarged to bring the material up to date. Data on cables, meters, carbon brushes, and standard electric motors have been added to "Electrical Engineering"; on transistors to "Electronic Engineering"; on gas distribution machinery and coke cleaning to "Gas Engineering"; on the ion-exchange process to "Steam Engineering"; on the twisting of long blades to "Steam Tur... on new mining machines and equipment; o... industrial safety information; on reinforcem... stresses in concrete and reinforced concrete; ... tax allowances and methods of calculation.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Power Hacksaw. EDWARD G. HERBERT, LTD. Atlas Works, Manchester, 19. The "Rapidor-Manchester" Major metal-cutting hacksawing machine, a modernised version of the "Rapidor-Manchester" light-duty saw. The machine takes 14 in. blades and has a 6 in. by 6 in. capacity swivel vice. Two-speed drive, giving 120 to 65 strokes per minute is standard. A patent split vice, enabling short lengths of material to be cut, is available as an extra in lieu of, or in addition to, the standard swivel vice. Illustrated leaflet.

Inserted Blade Milling Cutters. GEORGE H. ALEXANDER MACHINERY LTD., 82/4 Coleshill-street, Birmingham, 4. McCrosky serrated inserted blade milling cutters, now made in Great Britain. High-speed steel blades are retained in position by serrations ground from the solid and screw-operated wedges. The principle is applied to shank-type and shell end mills, face mills, half-side mills, slotting cutters, staggered-tooth mills and various special-purpose assemblies. Illustrated pamphlet.

Centre Lathe. WOODHOUSE AND MITCHELL (Proprietors, THOS. W. WARD LTD.), Wakefield-road, Brighouse, Yorkshire. 10½ in. centre lathe admitting 72 in. or 96 in. between centres. The lathe is driven by a 10 h.p. motor (50 or 60 cycles as required), and has 12 spindle speeds. A quick-change gearbox gives a wide range of English, metric, module, diametral and circular pitches, and coarse and fine sliding and surfacing feeds. Illustrated leaflet.

Clip-on Wattmeter. FERRANTI LTD., Hollinwood, Lancs. Clip-on wattmeter for the measurement of power in alternating-current circuits. Current transformer and movement of the iron-cored dynamometer type. Seven ranges from 0 to 3 to 0 to 300 kW at voltages up to 600 volts selected by thumb-operated switch. Voltage connections by spring clips. Current coil operated by a core opened by a trigger and closed round the conductor. Illustrated pamphlet 17W.

Paper-Insulated Cables. BRITISH INSULATED CALLENDER'S CABLES LTD., 21 Bloomsbury-street, London, W.C.1. Solid type, lead-sheathed, paper insulated cables for voltages up to 33 kV. Conformation with British Standard specification 480 (1954). Full technical particulars, including ratings, test conditions and details of manufacture. Numerous colour illustrations. Publication No. 358.

Small Vertical Milling Machine. GEORGE TAYLOR & SON (ENGINEERS) LTD., Swan-lane, Coventry. Vertical milling machine re-designed from an older model and incorporating new features. Working surface of table 17¾ in. by 5¼ in., with 9½ in. longitudinal, 3½ in. cross, and 8¼ in. vertical travel. Four spindle speeds, with three table feeds to each spindle speed. Illustrated leaflet.

Chains. JOHN GRIFFITHS & SON (GRIFF CHAINS) LTD., Dudley Wood, Cradley Heath, Staffordshire. Wrought-iron hand-welded and mild-steel electrically-welded chains. Sizes range from ⅛ in. to 1¼ in. and types include short link, long link, stud link and special-purpose chains. Forgings and fittings and chain slings are also described. Illustrated pamphlet.

Electromagnetic Vibrators. FRASER AND CHALMERS ENGINEERING WORKS, Erith, Kent. Details of vibrating feeders, screens, conveyors and tables. Also of barrel packers, foundry box shake-outs, bunker vibrators and test sieve shakers. Fully illustrated pamphlet (No. 481).

Miniature Solenoids. THE VARLEY MAGNET CO., Cambridge-row, Woolwich, London, S.E.18. First of a range of miniature solenoids for use in the electronic and accounting machine industries. Mechanical details and performance data. Illustrated leaflet.

Grinding Gauges. MORTIMER ENGINEERING CO., 210 Acton-lane, London, N.W.10. Grothkopp and Pratt gauges for automatic, dial-indicated, continuous gauging of ground surfaces. For use on external, internal and surface-grinding machines. Illustrated pamphlet.

HACKNEY "B" POWER STATION

UNUSUAL COOLING ARRANGEMENTS

A public electricity supply was first given in Hackney (East London), in 1901, the generating plant then consisting of two 500 h.p. Willans and Robinson engines driving two 150 kW Holmes dynamos coupled in tandem; and two Belliss and Morcom 1,000 h.p. engines driving two 300 kW dynamos also in tandem, making a total capacity of 1,800 kW. Steam was raised in Hughes and Stirling boilers fired with refuse, the pressure being 250 lb. per square inch; and distribution was on the three-wire direct-current system. Subsequently alternating current plant was installed bringing the capacity in 1938 up to 91 MW.

In 1947, it was decided to build a new station on an adjacent site with an initial capacity of two 30 MW turbo-alternators which were to be supplied from two 300,000 lb. boilers, although provision was also made for another 30 MW set with a possible development to 150 MW.

Work on this "B" station was began in 1948 and it was formally opened by the Mayor of Hackney (Councillor H. Foxon), who was previously Chairman of the Electricity Committee of the Borough Council, on April 14. It was designed by Mr. E. A. Mills, the then borough electrical engineer; and construction since Vesting Day has been carried out by the London Division of the Central Electricity Authority, of which Mr. H. V. Pugh is the present Controller, Messrs. L. G. Mouchel and Partners, Limited, being the consulting engineers for the building and civil engineering works.

COAL HANDLING AND STEAM RAISING PLANT

The foundations of the station are carried on piles, which rest on block pebbles the latter having been cemented in position at a depth of about 25 ft. The boiler house has a steel frame, while in the case of the turbine house, switch house and other buildings the frames are of reinforced concrete. The 300 ft. chimney is also of reinforced concrete its internal diameter being reduced at the top so as to increase the gas velocity and thus to increase the effective height of dispersal. An exterior view of the building appears in Fig. 1. The station is situated on the Hackney Navigation Cut and the coal handling plant which is built on the banks of this waterway, consists of two wharfside unloaders, which have been designed primarily to deal with barges of 125 tons capacity. The coal is lifted from the barges by grabs, which discharge into hoppers, whence it is taken by a belt conveyor with a capacity of 200 tons per hour and two elevators to a further conveyor system over the boiler house bunkers. Alternatively, it can be discharged by a third conveyor system to a stockyard, the capacity of which will be 50,000 tons. It can then be returned to the station by a reloader which operates along the full length of the storage ground.

The steam raising plant consists of two boilers, each of which is designed for an output of 300,000 lb. of steam per hour at 625 lb. per square inch and 865 deg. F. Firing is by means of pulverised fuel, which is supplied from three mills with an output of 9 tons per hour for each boiler and is delivered to the furnaces by exhausters. The burners are arranged on the tangential firing system and oil initiators, which are provided with automatic electrical igniters are fitted for lighting up purposes. These initiators also enter the furnace automatically to restore stable conditions should the flame in the combustion chamber fail during operations. Steam temperature control is maintained by tilting the burners by a Multelec regulator, which is operated by a thermocouple in the outlet pipe.

The boilers are designed for full automatic control. All the gas passes are cleaned by electrically operated sootblowers, which are controlled from a master control panel. These panels carry all the instruments which are necessary for efficient operation and also give an indication of excessive smoke entering the chimney. Flame induction is also brought out on the panel for observation by the operator. Make-up water is obtained from two central evaporating plants and is drawn either from wells or from the Metropolitan Water Board's system and is first softened in a base exchange softener.

The furnace gases are discharged to the chimney through electrostatic precipitators, which operate at 45 kV. direct-current and the ash and dust is removed by a water sluice system into a settling pit from which it is taken away by lorry.

GENERATING PLANT

The present generating plant of which a view is given in Fig. 2 comprises two 30 MW two-cylinder turbines, the high pressure cylinders of which are anchored at the high pressure inlet bearing, expansion of the casing taking place on the bed plate of the machine at the exhaust end of this cylinder. Expansion of the high pressure rotors takes place on half-claw couplings which are placed between them and the low pressure rotors. The glands are sealed by steam, which is fed through a pressure-reducing valve. Each turbine is directly coupled to a 34·285 MW air-cooled alternator, which generates at 7·3 kV so as to allow for a voltage drop across the reactors, which are connected to the London Electricity Board's 6·6 kV system.

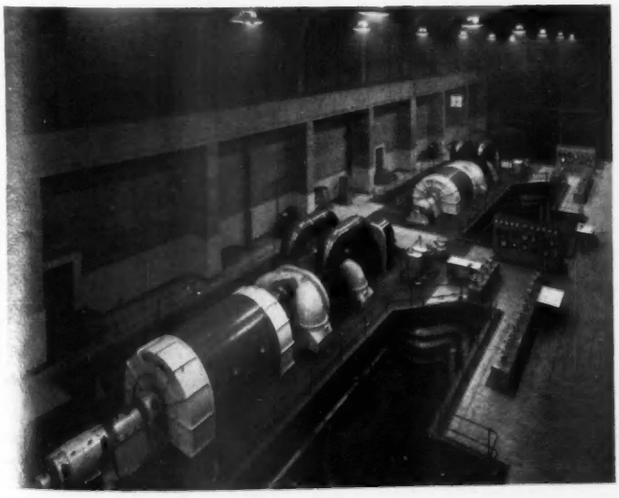


Fig. 2 View in the turbine room showing the 30 MW Parsons turbo-alternators.

Fig. 1 Exterior of the Hackney "B" power station, London, which was formally opened on April 14.

The turbines exhaust into a single-shell double-water compartment condenser with a cooling surface of 25,000 sq. ft., which will maintain a vacuum of 28·55 in. with a cooling water inlet temperature of 62·5 deg. F. The condensate passes through four stages of feed heating so that its temperature is increased to 345 deg. F. at the economiser inlet. The pressure is raised by electrically driven feed pumps which are capable of supplying all the water required by the boilers. There is also a turbine driven pump of 50 per cent. duty, which comes into action automatically should the feed pressure fail.

COOLING WATER ARRANGEMENTS

Cooling water is obtained from the River Lea the supply being supplemented at periods of low flow by a mechanical draught tower. The river intake works are situated at Middlesex Wharf, whence the water flows through a reinforced concrete conduit, 52 sq. ft. in cross section, for a distance of 675 yards to the station. It then passes through two rotating cup screens, 18 ft. in diameter, to the circulating pumps. After passing through the condensers the water enters a discharge chamber. This chamber is connected to the outlet culvert through which the water flows into the Hackney Cut Navigation. This system permits the warmer water from the outfall to run back along the Cut and over a weir into the River Lea.

The inlet water intake is extended under the discharge chamber and is connected through surge and screen chambers to the cooling tower. This cooling tower is in turn connected by a pipe to a further intake chamber on the east bank of the Cut. This pipe then continues to an emergency discharge into the river and can be used for disposing of any build-up in the water level in the Cut when the flood gates at its entrance are closed.

The mechanical draught cooling tower, which has been erected on the bank of the Cut is illustrated in Fig. 3. It is, as will be seen, a wooden structure, which is divided into eight separate compartments. The air flow through these compartments is provided by induced draught fans, while the tower is supplied with water from the Cut by two axial flow pumps, each of which has an output of 2¼ gallons per hour. This water, which is returned into the circulating water inlet culvert is sufficient for cooling both condensers without drawing a supply from the river.

The alternators are connected to 6·6 kV switchgear with a rupturing capacity of 150 MVA,

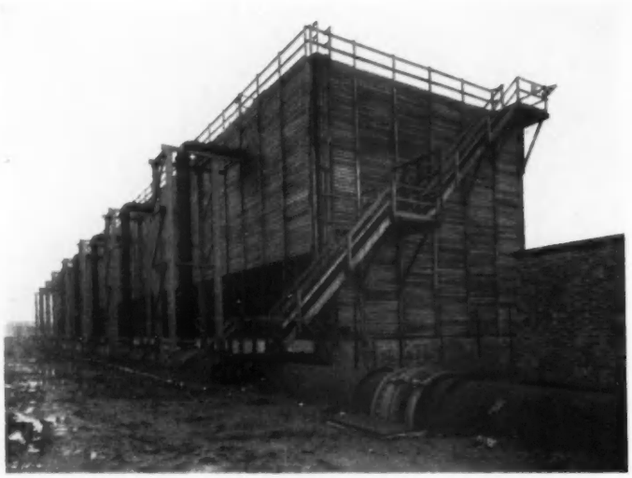


Fig. 3 Mechanical draught cooling tower for supplementing the supply from the river at periods of low flow.

which is installed in sectional houses and is regulated from a main control room. The auxiliaries are supplied at 415 volts through works transformers, with the exception of the motors driving the boiler feed pumps and cooling tower pumps which are operated at 6·6 kV.

Principal Contractors.—The principal contractors engaged in the erection of the station were:

J. L. Kier and Company, Limited, 9 Lygon-place, London, S.W.1 and John Morgan (London), Limited, Grosvenor-gardens, London, S.W.1 for the civil engineering work; Mitchell Engineering, Limited, Peterborough for the coal handling plant; Simon-Carves, Limited, Cheadle Heath, Stockport, for the boilers and ash handling plant; Jas. Howden and Company, Limited, Glasgow, C.5, for the fans and air heaters; the Sturtevant Engineering Company, Limited, Cannon Street, London, E.C.4, for the electrostatic precipitators; and International Combustion, Limited, Woburn-place, London, W.C.1 for the coal preparation and firing equipment. The turbo-alternators were supplied by C. A. Parsons and Company, Limited, Newcastle-upon-Tyne; the condensers by Worthington-Simpson, Limited, Newark; the circulating water pumps by Vickers-Armstrongs, Limited, Westminster, London, S.W.1; the induced draught cooling tower by Head, Wrightson and Company, Limited, Thornaby-on-Tees; and the boiler feed pumps by the Harland Engineering Company, Limited, Alloa. The 6·6 kV switchgear was manufactured by the British Thomson-Houston Company, Limited, Rugby and the 415 volt switchgear by the General Electric Company, Limited, London. The transformers were supplied by South Wales Switchgear, Limited, Blackwood, Mon.

FASTENING RAILS TO CONCRETE SLEEPERS

Forces Analysed in Shock-Proof Clamps

A steel clip, which can be quickly released and incorporates shock-absorbing pads, has been developed by British Railways for fastening rails to concrete sleepers and installed experimentally in a half-mile welded length of Class B2 goods line near Syston, Leicestershire, on a four-track section of the Midlands Division main line, London Midland Region.

The fastening, shown in the accompanying sketch, embodies some features of German practice in conjunction with the use of a grooved rubber pad; it has been evolved by Mr. D. Lindsay and Mr. J. C. Loach, of the British Railways Research Department, with the assistance of the British Rubber Producers' Research Association. Of the clip type, it is secured by means of a long screw run into a corrugated wood plug cast in the concrete sleeper. The plug itself, and the shape of the threads of the screw, are based on the well-known practice of the Deutsche Bundesbahn,* and is of beechwood which has been creosoted; should the necessity arise, it is intended that the plug will be removed by drilling and shelling so that it can then be replaced by a split plug and strips. The apparently inverted shape of the thread of the screw was evolved by research on the D.B. to find the best holding power of wood, against repeated pulls, when its fibres lie parallel to the axis of the screw.

The rail sits on a grooved rubber pad, 7½ in. by 5¼ in. by ¼ in. thick. The form of the wide V-shaped grooves has been recommended by the British Rubber Producers' Research Association and, together with the hardness of the rubber selected, gives a very satisfactory load-deflection characteristic of the pad. The pad, of course, serves to take up inequalities in the flat surfaces of the underside of the rail and in the concrete on which it sits and, by separating the two, prevents the concrete from being damaged by excessive local pressures.

For reasons given below, rubber has also been used at both ends of the clip, and rubber-bonded cork has been used under the head of the screw. If two steel objects make contact they will wear each other away when any relative movement occurs; but the "wear" is much more rapid when they are exposed to the weather, largely due to the removal of rust forming on the contacting surfaces. The rubber at the front of the clip prevents direct contact of the clip and the rail; at the same time the friction between the rail and the clip, and the resistance to creep of the rail, are both increased.

The use of synthetic rubber on the back of the clip was considered desirable after the experience gained from service tests started in 1950 with a small quantity of French-made clips; it was found that, in some cases, the concrete at the back of the clips was spalled by them. Synthetic rubber has been used so that it shall not be affected by oil and dirt collecting in the groove in which the back of the clip fits.

The rubber-bonded cork washer between the head of the screw and the clip has been used to absorb as much as possible of the rapid upward shocks otherwise imposed on the screw, the clip not being appreciably flexible. Some of the upward shocks from the rail will, of course, be absorbed by the rubber at the front of the clip, but it was considered desirable to incorporate another resilient component axially in line with the screw.

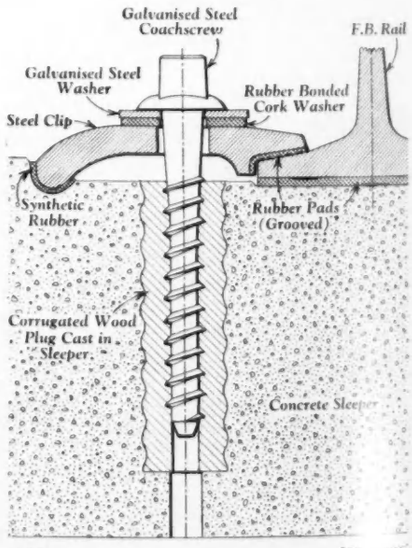
The rubbers at the two ends of the clips were inserted separately in the length at Syston—although the original proposal was to secure them to the clips during assembly so that they formed one component—and it is intended to do so in future. The clip is 3 in. wide, and the diameter of the hole through which the screw passes gives adequate clearance, so that side thrust from the rail is transmitted through the clip to the concrete at the back of it. The position of the screw is such that after it has been eased, the rail can be released by turning the clip, together with the rubber pads, through a right-angle.

The clips used at Syston, shown in the top illustration, are not identical with the design in the drawing. They have the same principal dimensions but, having been made in a small quantity and by a different process relatively quick for the initial trial, they differ in detail. The rubber at the back of the clip and the rubber-bonded cork washer under the head of the screw both supplement the insulation provided by the rubber at the front of the clip for track-circuiting purposes. At the same time, it is hoped the presence of rubber between all important surfaces will prevent appreciable wear and so minimise the amount of attention to be given to the fastening in service.

The screw, when tightened, exerts approximately 2½ tons on the clip and this, in turn, imposes about 1½ tons load on the rail. There is one clip on each side of the rail at each sleeper and thus the rail is clamped between rubbers exerting approximately 3 tons on it. On long welded lengths, clamping loads of this order are very beneficial in maintaining the rectangularity of the framework of the track against buckling tendencies, and in reducing the amount of movement at the ends of the length due to temperature changes in the rails.

Although there may not appear to be any very unorthodox ideas about this type of fastening, it incorporates several desirable features, and being practical, simple and robust, is expected to give good service. Indeed, British Railways have now planned to lay a fair number of additional stretches of track of this type, several of which it is hoped to install early next year.

Shock-proof assembly for securing F.B. rails to concrete sleepers.



The clamps exert a holding force of 3 t on each rail at every sleeper.

* Described in the *Bulletin of the International Railway Congress Association*, pages 150-157, March 1953.

ATOMIC ENERGY EVENTS REVIEWED

3—REACTOR EQUIPMENT AND RADIOACTIVE TRACERS

Concluded from page 245

In the third part of our article on nuclear developments during the last two months we deal exclusively with the products and techniques of private companies, including reactor control equipment, pumps for liquid metals, a television camera for viewing the interior of a reactor, a method of using radioactive tracers to determine cutting-tool wear and a model of the Dounreay reactor.

Many new items spring from the development of the nuclear reactor itself and typical of these is the thermal-reactor control equipment shown in Fig. 4. Made by the Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester 17, this unit comprises an actuating mechanism for the combined control and shut-off rods of a thermal reactor. The mechanism is designed to provide a slow " out " and two faster " in " speeds, and to hold the rod in any required position. It is also capable of giving a controlled shut-off independently of the electrical supply. The mechanism consists of a synchronous control torque motor, fed from a variable-frequency supply, driving through a 20 : 1 reduction gear on to a cable reel. The speed of the rods to the shut-off condition is controlled by a permanent-magnet eddy-current brake. Rod position indication is given by a geared Magslip transmitter. The entire mechanism is dry-lubricated by molybdenum disulphide. Metropolitan-Vickers are supplying 120 of these uni s for the Calder Hall A station.

ELECTRON LINEAR ACCELERATOR

The same company is at present building for subsequent installation at Harwell a 25 MeV electron linear accelerator, which is expected to be considerably more efficient and of higher power output than any similar machine yet built. It will be used to generate intense pulses of neutrons by the interaction of the electron beam with a uranium target for use in time-of-flight spectroscopy and other applications. In this machine, which is of the travelling-wave type, electrons are accelerated by the axial component of an electric field set up by the propagation of radio-frequency power in a wave guide of circular cross section. It will consist of six sections of accelerating wave-guide structure arranged in tandem. Each section is approximately 1 metre long and is energised by a 6 MW (peak) Klystron amplifier, which may be operated at a pulse length of 2 microseconds and a recurrence rate of up to 750 pulses per second, thus producing a mean power of 9 kW. It will be possible to set the electron pulse lengths at any of several values between 0·2 and 2·0 microseconds; the pulse recurrence rate can also be varied.

It has also been reported that Metrovick in collaboration with the U.K.A.E.A. are designing and building a 50 MeV proton linear accelerator for the Atomic Energy Research Establishment as the pilot section for a 600 MeV accelerator.

Of related interest is a 10 BeV (or 10^{10}eV) accelerator, 56 metres in diameter and having a magnet weighing 36,000 tons, said to be under construction in Russia.

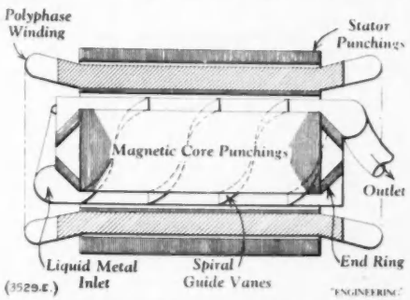


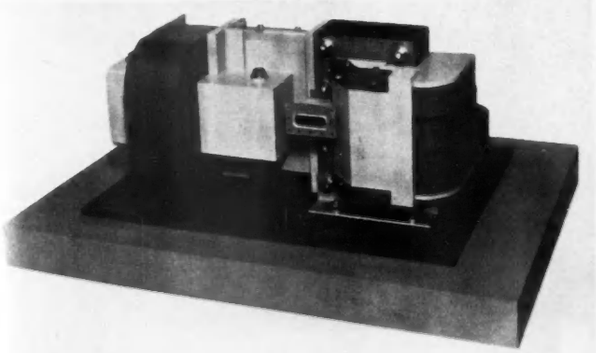
Fig. 5 Spiral induction pump (S.I.P.). Electromagnetic pumps, in which liquid metals are pumped by the force exerted on a conductor when carrying a current in a magnetic field, take several forms; the operation of an S.I.P is similar to that of an induction motor.

PUMPING LIQUID METALS

Nuclear reactors may employ liquid metals in two principal ways: firstly as coolants to give high rates of heat transfer at high temperatures, and secondly, where liquid fuels are to be used, as uranium solvents. Examples of the first group are sodium, sodium-potassium eutectic and lithium; and bismuth, which has the additional advantage of low neutron absorption, is typical of the second. To overcome problems of leakage, radioactive contamination and maintenance it is convenient to employ electromagnetic rather than mechanical pumping methods and to design the pump in accordance with the class of metals involved, since the density, viscosity and resistivity of the coolant group are low and of the solvents high. To meet these various needs the British Thomson-Houston Company, Limited, of Rugby, have in development four main kinds of pump: alternating-current conduction pumps (A.C.C.P.), which are generally used at lower power levels; direct-current conduction pumps (D.C.C.P.) for use with high resistivity metals at all power levels; spiral induction pumps (S.I.P.) for intermediate power levels or low-flow and high-pressure applications; and annular induction pumps. The last group is further divided into two categories: the annular linear induction pumps (A.L.I.P.) for high power levels from approximately 3 h.p. output upwards, and re-entrant annular induction pumps (R.A.L.I.P.), also for high power levels. All systems have the following advantages: they include no moving parts, glands or bearings; pump length—particularly in the first kind—can be many times shorter than in the case of equivalent mechanical pumps without introducing cavitation, so economising in the quantity of liquid metal required for a given circuit; and finally the efficiency of electromagnetic pumps is as good as if not better than corresponding mechanical pumps.

Fig. 4 Metrovick thermal-reactor equipment designed to control the insertion and withdrawal of reactor control rods.

In pumping electromagnetically, force is transmitted to the fluid by contriving that it passes through a magnetic field while carrying a current at right angles both to the field and to its direction of motion. There are two general methods of achieving this: in the first, current is led from one outside conductor to another through the walls of a pipe and so through the liquid; and in the other the current is induced wholly within the liquid. Pumps using the first method (conduction pumps) fall into two categories; in the D.C.C.P. system the pump operates with direct current and a fixed magnetic field, and in the A.C.C.P. system with a simultaneously alternating magnetic field and current.



g. 6 Alternating-current conduction pump (A.C.C.P.) for pumping liquid muth. Bismuth may be used as a solvent for uranium in reactors where the fuel is to be in fluid form.

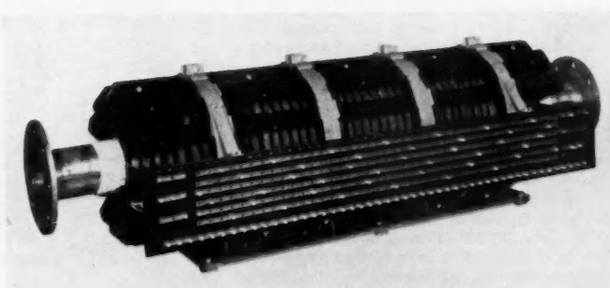
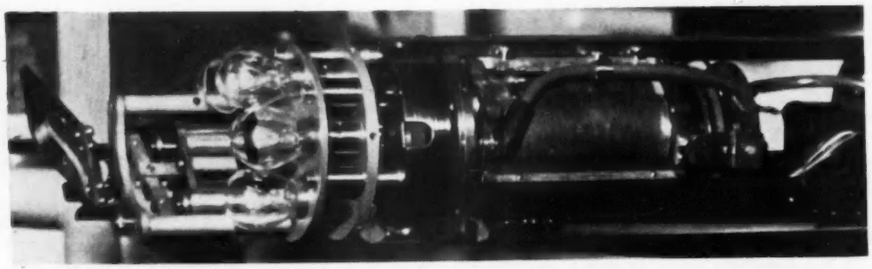


Fig. 7 Annular linear induction pump (A.L.I.P.) with cover removed. An annular channel encloses a radially laminated central core and is itself enclosed by a polyphase winding.



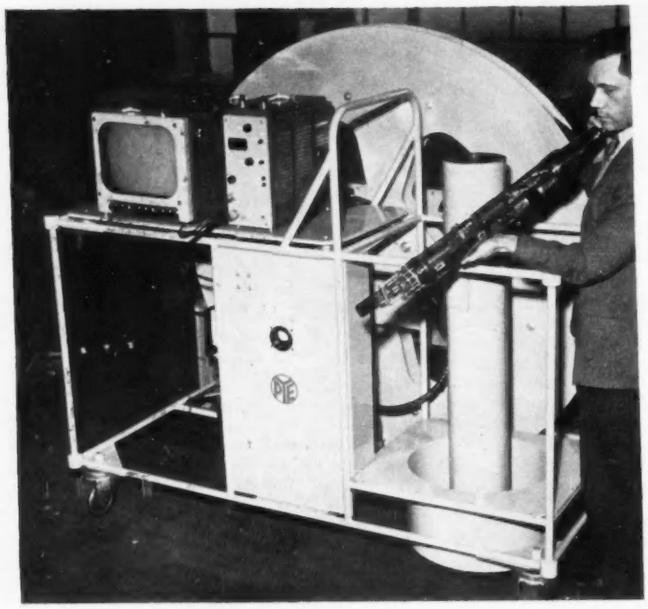


Fig. 8 Close-up view of camera head (without stainless-steel casing) of Pye television camera for observing the interior of a nuclear reactor in operation. The remotely controlled rotatable mirror at the left-hand end permits all-round viewing.

Fig. 9 Complete television camera unit showing camera head, cable, control unit and monitor. Since the head and cable may be exposed to temperatures up to 200 deg. C. carbon dioxide supplied through a flexible hose is used for cooling purposes.

Direct-current conduction pumps, which may be used for pumping bismuth, suffer from the considerable disadvantage that electrode-current requirements need to be of the order of many thousand amperes for one volt; for example, a 100 h.p. pump would require 100,000 amperes at 2·5 volts, and an efficiency of about 40 per cent. can be achieved at this size. A.C.C.P. systems ease the current supply problem but are less efficient, particularly in large sizes; however, they are useful in smaller sizes for pumping metals of both sodium and bismuth types. A pump of this kind is shown in Fig. 6.

INDUCTION PUMPS

The second method, in which current is induced in the liquid metal, covers the S.I.P., A.L.I.P. and R.A.L.I.P. systems. The spiral induction pump, the principle of which is illustrated diagrammatically in Fig. 5, operates in a similar manner to the induction motor and resembles a standard polyphase stator in construction with a fixed core and a large air gap, through which are wound several turns of a rectangular pipe containing the liquid metal; end rings are necessary in principle to establish the desired axial electric current. The field is of course radial, so the flow is circumferential, and the channel walls or guide vanes ensure that the liquid moves through the pump.

The linear induction pump operates on the same principle, except that the channel is straight and the travelling waves of field, flux and current move axially. Two main versions of this system exist. One is the flat form in which the channel is rectangular with side bars on each side, performing the same function as end rings in the induction motor; the winding is of the conventional polyphase type, though flat on each side of the channel. An alternative form (A.L.I.P.), which is shown in Fig. 7, employs an annular channel enclosing a radially laminated central core and being itself enclosed by a polyphase winding made up of pancake coils n radially laminated slotted punchings. The pump illustrated has an efficiency of 35 per cent. and a power factor of 0·2. Inaccessibility of the winding in annular linear induction pumps can be avoided, either by splitting the winding so that it can be removed from the pipe, or by adopting a reverse-flow form of construction (R.A.L.I.P.) in which the fluid enters within a pipe inside the central core and reverses direction at the end to flow in the annular space between core and winding. The coils and slotted yoke can then slide over the free end. The table below gives operating data of pumps already designed or in process of manufacture. A more general and detailed treatment of this subject is given in a technical article on page 268 of this issue.

TABLE. *Data on B.T.H. Electromagnetic Pumps*

Type	Metal	Flow (gals. per min.)	Pressure (lb. per sq. in.)	Working temp. (deg. C.)
D.C.C.P. spiral	Bi	0·6*	50	500
A.C.C.P. ..	Hg	6	15	110
A.C.C.P. (Fig. 6)	Bi	15	15	450
S.I.P. (Fig. 5) ..	Na	10	100	500
A.L.I.P. (Fig. 7)	Na-K	420	14	175
R.A.L.I.P. ..	Na	400	50	500

* Larger types are in course of development.

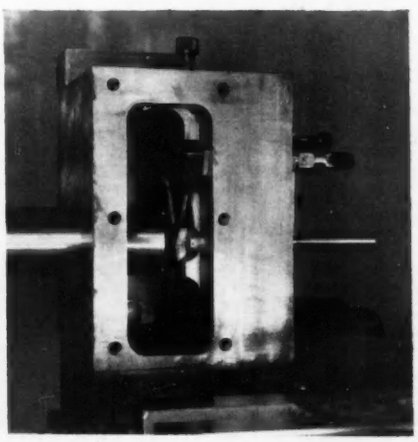
B.T.H. have also considerable experience in the manufacture of metering and control equipment for reactors, and have made equipment of this kind for the Windscale piles and for the Atomic Energy Research Establishment.

TELEVISION CAMERA FOR REACTORS

A television camera suitable for use inside a nuclear reactor has recently been completed by Pye Limited of Cambridge. The camera, which is based on the firm's normal industrial television equipment and makes use of special materials, is illustrated in Fig. 8. For ease of manipulation, the camera carries its own source of illumination consisting of four small but powerful bulbs grouped round the camera's lens, as can be seen in the illustration; to permit all-round viewing the unit includes a remotely controlled rotatable mirror, which can also be seen. Since the equipment is to be used while the atomic pile is active, it is designed to be operated at a distance from a position of safety, and is housed in a thin stainless-steel casing 3½ in. in diameter and 30 in. long. The complete apparatus, as shown in Fig. 9, including the camera and its 75 ft. of cable, the control unit and the monitor, is mounted on a trolley. As the camera is likely to be subject to temperatures up to 200 deg. C., the control cables leading to the camera head are enclosed in a flexible hose through which carbon dioxide is pumped to cool the exposed parts. Radioactive dust can be removed from the camera, after its withdrawal from the reactor by washing down.

CHECKING CUTTING-TOOL WEAR

The use of radioactive isotope tracers in industry is already widespread and in particular they have been found useful in the investigation of engine wear. Recently, cutting-tool wear has also been studied in this way. Cutting-tool life involves three main factors: the material to be cut, the form and composition of the tool itself and the nature of the cutting oil. With these three variables the number of possible combinations is large and tests by orthodox methods are necessarily very long—of the order of several months—and very expensive. By use



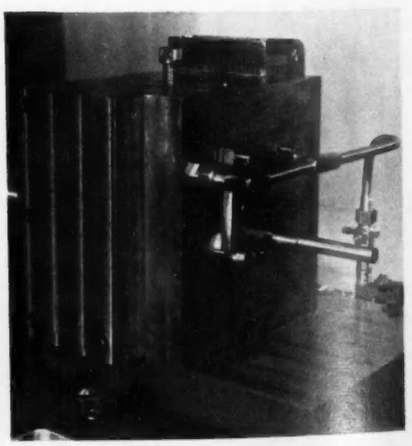


Fig. 10 Interior (left) and exterior (right) of cutting chamber, which serves to protect the operator from radiation, prevent loss of cutting fluid and collect metal chips, during radioactive tracer tests of machine-tool cutter wear carried out by Alexander Duckham and Company. By checking the activity present in a given sample of metal chips with a scintillation counter (Fig. 11), the quantity of metal worn from an irradiated cutting-tool bit can be estimated.

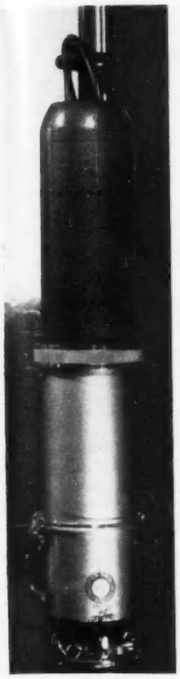


Fig. 11 Scintillation counter (see Fig. 10). A few seconds of cutting are required to produce results which formerly required many months and expenditure of several thousand workpieces.

of radioactive cutting tools, Alexander Duckham and Company, Limited, of Hammersmith, London, W.6, have reduced the duration of complete tests to a matter of hours (or seconds of actual cutting) and increased the accuracy of the results. As an indication of the improvement in economy, it has been stated that, whereas it had formerly been necessary to cut some thousands of components to obtain appreciable wear, it was now possible to perform a test with as little as a $\frac{1}{4}$ lb. of metal. The tests have also the advantages of simplicity and repeatability. Alexander Duckham and Company are primarily concerned with the selection of optimum cutting oils for given duties and their effect on tool life, but other related tests will also be performed.

To apply this method it is of course necessary to choose a cutting-tool material which can be rendered radioactive by irradiation in a nuclear reactor, but fortunately standard tools contain elements which when irradiated are converted to isotopes having conveniently long half lives. For example, the composition of the Wimmet X. 8 tool is: tungsten cabide 77 per cent., cobalt 8 per cent., and titanium carbide 15 per cent.; cobalt 60, which emits beta and gamma radiation, has a half life of 5·2 years and tungsten 185, which emits beta radiation only, has a half life of 73 days. Tools of this kind were sent to Harwell and irradiated to give a total activity of beta and gamma radiation of 15 millicuries per gram of tool tip (10 of beta and 5 of gamma). However, beta radiations possess only slight penetration powers and poor recording qualities due to chip piling, so that gamma rays alone are used for these studies. A cutting tool so activated is estimated to give some 80 minutes of cutting time per tool edge, but cutting tests of six to ten seconds duration have proved to yield sufficient wear products to give gamma radiation counts on the scintillator of three to five counts per minute (both coolant and chips can be checked in this way, though the chips retain some 95 per cent. of these products). Hence, about 500 tests can be carried out once the machine tool has been set up.

Safety precautions are essential and considerable care must be taken to protect the operator from radiation. Fig. 10 shows the interior and exterior of the cutting chamber used by Alexander Duckham's for this purpose; it is made of steel, 1 in. thick, and includes a cutting-fluid circulating system, which supplies fluid from two jets.

Tool bits approximately $\frac{1}{4}$ in. square and $\frac{3}{32}$ in. thick weighing some 15 gm. are used and cutting proceeds until approximately 50 gm. of chips are produced. These are washed, dried and weighed and exposed in the scintillation counter shown in Fig. 11. From the count, wear can be checked against a standard.

DOUNREAY REACTOR MODEL

In our issue of August 26 last year (vol. 180, page 280, 1955) we gave a description of the fast breeder reactor now under construction at Dounreay. One of the firms engaged in this work is John Thompson, Limited, of Wolverhampton, who have built a scale model of the installation to check theoretical calculations and as a guide to assembly. Figs. 12 and 13 show views of the model from above and from one side, and illustrate the layout of the heat-exchanger pipework and pumping circuits with respect to the core. In Fig. 13 the model can be seen with the nearside heat-exchangers removed; the coolant loops emerge from the reactor core and pass out through the concrete shielding (bottom left). The horizontal cylinders towards the top are electromagnetic pumps and the vertical cylinders nearby contain cold traps. The form of the concrete shielding corresponds to the curvature of the 135 ft. diameter containing sphere, in which it is enclosed.

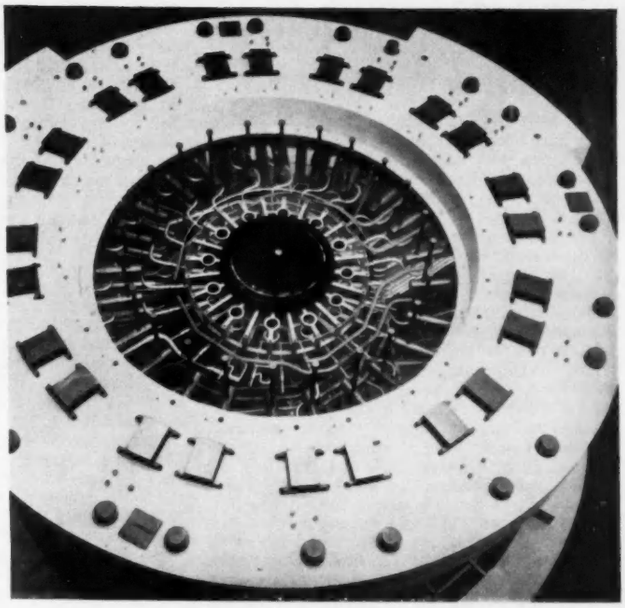


Fig. 12 To check calculations and layout John Thompson, Limited, have built a scale model of the fast breeder reactor now under construction at Dounreay. It shows the arrangement of heat-exchanger pipework and pumping circuits with respect to the core.

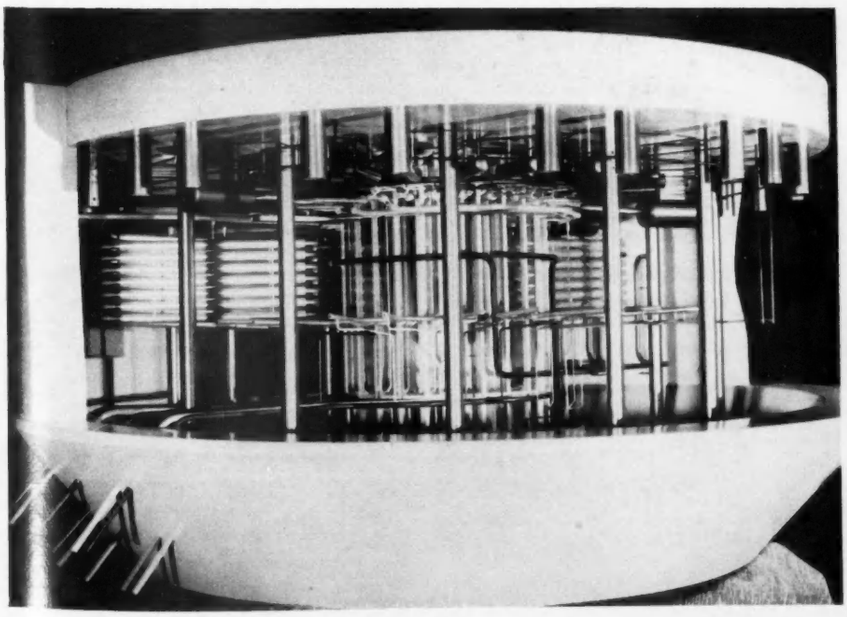


Fig. 13 Model of Dounreay reactor with nearside heat-exchangers removed. The coolant loops emerge from the reactor core and pass out through the concrete shielding (bottom left). The horizontal cylinders towards the top are electromagnetic pumps and the vertical cylinders nearby contain cold traps.

LIDO REACTOR

Supplementary News.—One of the models included in the United Kingdom Atomic Energy Authority's display at the British Industries Fair represents LIDO, a research reactor at present under construction at the Atomic Energy Research Establishment, Harwell. LIDO is a reactor specifically designed to enable shielding problems to be investigated. Hitherto, relatively little effort has been made to minimise shielding size and weight. This is a problem of great importance in the design of mobile reactors and must also be considered for power station reactors in order to keep down capital cost.

The reactor is of the thermal type, employing enriched uranium as fuel and light water as both moderator and coolant. The core is suspended in a tank of water from a trolley which enables it to be moved to any part of the tank. Sufficient depth of water is maintained over the core to provide vertical shielding, and horizontal shielding is effected by the concrete walls of the tank. In two areas, one incorporating a corner of the tank, this concrete is cut away and replaced by aluminium "windows." These form the working faces, and experiments can be built up adjacent to them on the outside. When measurements are to be made the core can be moved closer to them on the inside. Experiments may also be assembled inside the tank. To facilitate this, the core can be moved into a small bay at one end of the tank and isolated from it by a watertight door. LIDO is due to be completed towards the end of 1956.

In Parliament

SHIPBUILDING ORDERS

Many matters of technical and scientific importance have been raised in the House of Commons during the past few days, notwithstanding the large amount of parliamentary time which has been occupied by discussions on the Budget proposals and the economic situation. In reply to a question by Mr. Paul Williams (Conservative), the Civil Lord of the Admiralty, Mr. S. Wingfield Digby, said that orders for 64 merchant ships of a total of about 325,000 gross tons were licensed for construction in United Kingdom shipyards during the first quarter of the present year. Orders for 20 of these ships, totalling approximately 146,000 gross tons, were licensed for construction in shipyards on the North East Coast during that period.

As to the means being taken to ensure improved supplies of steel to British shipyards, Mr. Digby said that exports of steel plates had been curtailed in the interest of users in this country. There was likely to be some increase in home production during the year and the Iron and Steel Board was also reviewing, in association with steel-producing firms, means for further improving the production of this commodity. Discussions on the subject between the First Lord of the Admiralty and the President of the Board of Trade were continuing.

SUPPLY OF SCIENCE GRADUATES

Suggestions that the Services appeared to be absorbing too large a share of scientific manpower, of which the nation was so short, were put forward by Mr. James Callaghan (Labour). In reply, Mr. Nigel Birch, the Secretary of State for Air, said that approximately 7,500 graduate scientists, and technologists of equivalent status, were employed in a civilian capacity in defence establishments. In addition, about 3,000 men with corresponding qualifications were engaged on national service. The number of officers and men in the three Services who had scientific qualifications of this standard was not readily available. The figures quoted included men employed in the Ministry of Supply.

The demands of the Services and the Ministry of Supply, Mr. Birch pointed out, were kept in check by the total sum allowed for by the Chancellor of the Exchequer in his Budget for expenditure on research and development.

Employment of Engineers and Scientists

Mr. Austen Albu (Labour) asked the Minister of Labour and National Service for the terms of reference and the composition of the committee which was investigating the supply and utilisation of scientific manpower. He was informed by Mr. Iain Macleod that an inquiry was being carried out into the numbers and distribution of scientists and engineers employed in industry and in other fields of work. This investigation was being undertaken by the Social Survey on behalf of the Ministry of Labour and the Department of Scientific and Industrial Research. The results would be considered by the Technical Personnel Committee of the Ministry of Labour, and by the Committee on Scientific Manpower of the Advisory Council on Scientific Policy, which reported to the Lord President of the Council.

Orders for Atomic Power Stations

Mr. R. A. Butler, the Lord Privy Seal, stated that the responsibility for securing contracts for the supply of atomic power stations to overseas countries rested with the companies which were able to supply these constructions. A number of British companies were engaged in designing atomic power stations, in conjunction with the United Kingdom Atomic Energy Authority and the electricity authorities in this country. Those activities should enable these firms to undertake export orders in due course. In reply to Mr. R. Moss (Labour), the Minister said he would be glad to study any material which might be submitted to him tending to show that American propaganda in Australia was stigmatising British achievements in the nuclear-energy field as obsolete. Mr. Butler added that he had read the third annual report of the Australian Atomic Energy Commission and that document appeared to him to give opportunity for the export of these power stations when the proper time came.

Enriched Nuclear Fuel

Later, the Minister told Mr. Moss that the development of medium-sized nuclear reactors specially designed for export had not yet reached a sufficiently advanced stage for a prototype to be built, so that the supply of enriched fuel for use in such a connection had not arisen. He agreed with Mr. Moss that the construction of medium-sized reactors for export was an important matter, but considered that it would be premature to issue a White Paper entitled "Nuclear Power and the Export Trade." Mr. Callaghan referred to the amount of enriched fuel and the number of scientists and technologists employed for defence purposes and asked whether, in view of the development in that field, steps could now be taken to build these stations more quickly and to arrange for the supply of enriched fuel to them. Mr. Butler undertook to discuss these matters with the Lord President of the Council.

Atomic Energy Contracts

Answering Mr. A. M. F. Palmer (Labour), who inquired as to the principle by which industrial firms were selected to collaborate with the Atomic Energy Authority in the development of nuclear energy for industrial purposes, Mr. Butler said he understood that the Authority followed, in normal circumstances, the standard Government practice of placing its contracts by tender. Wh[illegible] circumstances made competitive tend[illegible] cedure impracticable, or where forms [illegible] boration otherwise than by contr[illegible] involved, firms were selected accordi[illegible] resources of experience and skilled m[illegible] which they were prepared to devote to [illegible] concerned. Mr. Donald Wade (Liberal) asked if the Minister was aware that the selection of certain civil engineering contractors, without asking for tenders or ascertaining if other firms were able to undertake the work, had caused some concern as to whether this action might create a precedent in this new sphere of co-operation between the State and private industry. Mr. Butler replied that he had set out the general basis on which these matters were arranged in his statement to the House on March 14. (This was referred to on page 191 of our issue of April 6 last.)

Oxygen-Blown Converter Steel

The Parliamentary Secretary to the Admiralty was asked by Mr. Hector Hughes (Labour) for a statement as to the progress being made regarding the use of oxygen-blown basic converter steel for shipbuilding purposes. In reply, Mr. Digby said that oxygen-blown basic converter steel was not at present produced in this country. British steel manufacturers were, however, in touch with the development of the process and experiments were being conducted.

Mining Subsidences

Mr. Duncan Sandys, Minister of Housing and Local Government, promised Mr. Ellis Smith (Labour) that a statement on mining subsidences with reference to local authorites' interests, and in reply to representations made to him by a deputation from the National Standing Committee on Mining Subsidence, would shortly be made by the Minister of Fuel and Power.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

LIVERPOOL
"Underfloor Duct System," by W. J. Mann. Liverpool Branch. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Fri., May 4, 7.30 p.m.

MANCHESTER
Film Evening. Manchester Branch. Engineers' Club, Albert-square, Manchester. Wed., May 2, 7.30 p.m.

PRESTON
"Ventilation in Industry," by R. W. James. Preston Branch. Chamber of Commerce, 49a Fishergate, Preston. Wed., May 2, 7.30 p.m.

READING
Annual District Meeting. Oxford, Reading and District Branch. Letters Lecture Theatre, University of Reading, London-road, Reading. Tues., May 1, 6 p.m.

British Productivity Council

LONDON
Films and Discussion on Productivity Problems. Organised by the North London Productivity Committee. National College of Rubber Technology, Northern Polytechnic, Holloway-road, N.7. Thurs., May 3, 2.30 p.m. (Tickets 2*s.* 6*d.*)

Chemical Society

LONDON
Various original papers. Thurs., May 3, 7.30 p.m.

EXETER
"Surface Diffusion," by Professor R. M. Barrer. Exeter Branch. Washington Singer Laboratories, Exeter. Thurs., May 3, 5 p.m.

Illuminating Engineering Society

LEICESTER
Annual General Meeting. Leicester Centre. Offices of the East Midlands Electricity Board, Charles-street, Leicester. Mon., May 14, 6 p.m.

LIVERPOOL
Annual General Meeting. Liverpool Centre. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Wed., May 16, 6 p.m.

NOTTINGHAM
Annual General Meeting and Brains Trust. Nottingham Centre. Offices of the East Midlands Electricity Board, Smithy-row, Nottingham. Thurs., May 3, 6 p.m.

Incorporated Plant Engineers

LONDON
"Repairs of Cracked Castings: Modern Methods," by N. Tinwell. London Branch. Royal Society of Arts, John Adam-street, W.C.2. Tues., May 1, 7 p.m.*

LEEDS
Film on "The Volga Don Canal." West and East Yorkshire Branch. The University, Leeds. Mon., April 30, 7.30 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

*** An asterisk is placed where it is understood that tea is available prior to the time stated.**

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
British Productivity Council. Apply to Mr. Charles Cooper, 126 The Ridgeway, Enfield. (HOWard 2611.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester 3. (Blackfriars 6178.)
Institute of Petroleum, Manson House, 26 Portland-place, London, W.1. (LANgham 2250.)
Institute of Physics, 47 Belgrave-square, London, S.W.1. (SLOane 9806.)
Institute of Refrigeration, New Bridge Street House, New Bridge-street, London, E.C.4. (CENtral 4694.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institute of Welding, 2 Buckingham Palace-gardens, London, S.W.1. (SLOane 9851.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.
Physical Society, 1 Lowther-gardens, South Kensington, London, S.W.7. (KENsington 0048.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Institution, 21 Albemarle-street, London, W.1. (HYDe Park 0669.)
Royal Society, Burlington House, Piccadilly, London, W.1. (REGent 3335.)
Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Society of Engineers, 17 Victoria-street, London, S.W.1. (ABBey 7244.)
Society of Instrument Technology, 20 Queen [illegible]-street, London, W.1. (LANgham 4251.)
Women's Engineering Society, 25 Foubert's-place, [illegible], W.1. (GERrard 5212.)

LEICESTER
Discussion on "Flexible Couplings." Leicester Branch. Leicester College of Art and Technology, The Newarkes, Leicester. Wed., May 2, 6.30 p.m.
MANCHESTER
Film on "Mechanical Handling," introduced by H. A. Collman. Manchester Branch. Engineers' Club, Albert-square, Manchester. Tues., May 8, 7.15 p.m.
PETERBOROUGH
Various short papers. Peterborough Branch. White Lion Hotel, Church-street, Peterborough. Thurs., May 3, 7.30 p.m.
SOUTHAMPTON
"Southampton Harbour," by J. P. M. Pannell. Southern Branch. Polygon Hotel, Southampton. Wed., May 2, 7.30 p.m.

Institute of British Foundrymen

COVENTRY
"Investment Casting for Aircraft Engines," by D. F. B. Tedds. Coventry Section. Coventry Technical College, Coventry. Tues., May 15, 7. 30 p.m.

Institute of Petroleum

LONDON
"Recent Oil Development in France," by P. S. Hirtz. Wed., May 9, 5.30 p.m.*

Institute of Physics

LONDON
Symposium on "Principles of Penetrant Methods." Papers will be read on the problems encountered in the use of penetrant methods of industrial inspection, by H. L. Carson, W. G. Cook and Dr. R. Schnurmann; and on the physics of the problems and the research needed for their solution, by Sir Eric Rideal, Dr. E. W. J. Mardles, A. de Waele and Dr. K. Weissenberg. Non-Destructive Testing Group. Fri., May 4, 6.30 p.m. (Admission by ticket.)

Institute of Refrigeration

LONDON
"Use of Radioactive Techniques in Refrigeration Engineering," by D. B. Smith. Joint Meeting with Physical Society. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Thurs., May 3, 5.30 p.m.* (Alteration of date.)

Institute of Road Transport Engineers

LIVERPOOL
Annual General Meeting. West Regional Centre. Adelphi Hotel, Lime-street, Liverpool. Wed., May 2, 7.30 p.m.
NOTTINGHAM
Annual General Meeting. East Midlands Centre. Mechanics' Institute, Nottingham. Tues., May 1, 7.30 p.m.

Institute of Welding

FELIXSTOWE
Annual Spring Meeting.
"The Case for Site Welding," by G. H. Smith; and Report by the Institute's Structural Sub-Committee on "Welding and the Structural Steelwork Industry." Cavendish Hotel, Felixstowe. Fri., May 4, 10 a.m.
"Welding Progress in a General Engineering Workshop," by J. A. Edwards and J. O. H. Nice; and "Recent Progress in the Fabrication of Thermoplastic Materials," by G. Haim. Cavendish Hotel, Felixstowe. Sat., May 5, 10 a.m.
Various Works Visits, Thurs., May 3, and Fri., May 4.

Institution of Civil Engineers

LONDON
"Pumping Problems: Present and Future," by Herbert Addison. Hydraulics Division. Joint Meeting with the Institution of Mechanical Engineers. Tues., May 1, 5.30 p.m.*
"The Construction of Middleton Connecting Sewer in North Manchester," by E. H. Collier. Public Health Division. Tues., May 8, 5.30 p.m.*
"The Allowable Settlements of Buildings," by Professor A. W. Skempton and Dr. D. H. MacDonald. Structural and Building Division. Thurs., May 10, 5.30 p.m.*

Institution of Electrical Engineers

LONDON
Discussion on "Methods of Fault Detection and Location in Impulse Tests on Transformers," to be opened by F. S. Edwards. Joint Meeting of the Measurement and Supply Sections. Tues., May 1, 5.30 p.m.*
Convention on "Electrical Equipment of Aircraft," organised by the Utilization Section. About 20 papers will be presented for discussion. Opening Session, Wed., May 2, 5.30 p.m. Session 2 "Electricity in Aircraft," Thurs., May 3, 10 a.m. Session 3 "Aircraft Electrical Systems," May 3, 2.30 p.m. Session 4 "Machine Equipment," May 3, 5.30 p.m. Session 5 "System Equipment," Fri., May 4, 10 a.m. Session 6 "Installation and Maintenance," May 4, 2.30 p.m. (Registration fee to non-members £1.)
"Ship Stabilisation: Automatic Controls, Computed and in Practice," by J. Bell. Measurement and Control Section. Tues., May 8, 5.30 p.m.*
"Time Sharing as a Basis for Electronic Telephone Switching: A Switched Highways System," by L. R. F. Harris. Radio and Telecommunication Section. Wed., May 9, 5.30 p.m.*
BIRMINGHAM
"Problems of Hydro-Electric Design in Mixed Thermal-Hydro-Electric Systems," by T. G. N. Haldane and P. L. Blackstone. South Midland Centre. James Watt Memorial Institute, Great Charles-street, Birmingham. Mon., May 7, 6 p.m.
DUNDEE
Annual General Meeting. North Scotland Sub-Centre. Electrical Engineering Department, Queen's College, Dundee. Thurs., May 10, 7 p.m.
EDINBURGH
Annual General Meeting. South East Scotland Sub-Centre. Carlton Hotel, North Bridge, Edinburgh. Tues., May 8, 7 p.m.
MANCHESTER
Annual General Meeting. "The Control and Instrumentation of a Nuclear Reactor," by A. B. Gillespie. North Western Centre. Engineers' Club, Albert-square, Manchester. Tues., May 1, 6.15 p.m.

Institution of Mechanical Engineers

LONDON
"Pumping Problems: Present and Future," by Herbert Addison. Joint Meeting with the Institution of Civil Engineers at the Institution of Civil Engineers, Great George-street, S.W.1. Tues., May 1, 5.30 p.m.*
"Three-Dimensional Motion in Axial-Flow Impellers," by D. P. Hutton; and "The Performance of an Axial-Flow Pump," by Dr. E. A. Spencer. Hydraulics Group. Fri., May 4, 5.30 p.m.*
"The Influence of the Gas-Turbine Axial-Flow Aero Engine on Wide-Manufacturing Methods," by R. R. Whyte. Industrial Administration and Engineering Production Group. Fri., May 11, 5.30 p.m.*

Institution of Production Engineers

BIRMINGHAM
Film Evening. Birmingham Graduate Section. James Watt Memorial Institute, Great Charles-street, Birmingham. Tues., May 8, 7 p.m.

Junior Institution of Engineers

BIRMINGHAM
"Electronic Control: The New Power in Industry," by John A. Sargrove; and Mr. Sargrove's film "The First Automatic," showing the production of a wireless receiver made entirely by machines. Midland Section. James Watt Memorial Institute, Great Charles-street, Birmingham. Wed., May 2, 7 p.m.

Physical Society

LONDON
"Use of Radioactive Techniques in Refrigeration Engineering," by D. B. Smith. Low Temperature Group. Joint Meeting with the Institute of Refrigeration. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Thurs., May 3, 5.30 p.m.* (Alteration of date.)

Royal Aeronautical Society

LONDON
All-Day Discussion on "Problems of Supersonic Flight." "Propulsion," by A. V. Cleaver; "Aerodynamics," by P. J. Dunctон; "Structures," by D. J. Farrer; and "Cabin Conditions," by H. H. Gardner. Institution of Civil Engineers, Great George-street, S.W.1. Wed., May 9. 10 a.m.

Royal Institution

LONDON
"The Exploration of the Upper Atmosphere," by Professor H. S. W. Massey. Fri., May 11, 9 p.m.

Royal Society

LONDON
"Spin Fluctuation Scattering of Neutrons and the Ferro-Magnetic State in Iron" by R. D. Lowde; "Brueckner Theory of Nuclear Structure," by R. J. Eden. Thurs., May 3, 4.30 p.m.*

Royal Society of Arts

LONDON
"Modern Welding," by Dr. H. G. Taylor. Third Lecture. Mon., April 30, 6 p.m.
"Beauty in Danger: The Urban Scene," by Professor Sir Hugh Casson. Wed., May 2, 2.30 p.m.

Society of Engineers

LONDON
"Oil-Fired Packaged Portable Boilers," by D. F. Brice. Geological Society, Burlington House, Piccadilly, W.1. Mon., May 7, 5.30 p.m.*

Society of Instrument Technology

MANCHESTER
Annual General Meeting. "Chemical Balances," by Dr. G. F. Hodsman. Manchester Section. College of Technology, Sackville-street, Manchester. Tues., May 8, 7.30 p.m.
NEWCASTLE-UPON-TYNE
Annual General Meeting. Newcastle Section. Stephenson Building, King's College, Newcastle-upon-Tyne. Wed., May 9, 7 p.m.

Women's Engineering Society

LONDON
Discussion on "Mining Machinery." Hope House, 45 Great Peter-street, S.W.1. Mon., May 14, 7 p.m.*

BRITISH INDUSTRIES FAIR

ELECTRICAL EQUIPMENT AT OLYMPIA

The British Industries Fair, which was first held in 1915 and has since taken place almost every year in both London and Birmingham, has this year been organised on new lines. The London section has been held at two different times—under the auspices of British Industries Fair, Limited—in February when mainly consumer goods were displayed; and this week when the exhibits consist principally of capital goods and equipment from the electrical and chemical and allied industries; office and printing machinery, scientific, optical and medical instruments are also being shown.

At Castle Bromwich the Fair, which is organised by the Birmingham Chamber of Commerce, includes a wide range of mining, mechanical handling, building and other machinery as well as displays of domestic apparatus and of equipment of a miscellaneous character. Both Fairs opened on April 23 and will continue until May 4.

A PROFOUND CHANGE

Next year a profound change is contemplated. The Government guarantee to the company responsible for the London section of the Fair is being withdrawn, so that it will be obliged to close down. It is hoped, however, that a number of the exhibitors will transfer to Birmingham where it is intended, if possible, to absorb them into the four existing groups—engineering, electrical, building and hardware.

The electrical section at this year's London Fair, which is being held at Olympia, comprises, some 80 exhibitors the displays of about 25 of which are exclusively devoted to domestic apparatus. This apparatus also figures on other stands. Another half-dozen are associations and about the same number are cable manufacturers. There are also a number of firms which should not strictly be regarded as electrical. The larger firms in the industry are well represented, as are a number of specialist concerns, particularly those producing switchgear. The representation would probably have been larger had it not been for the exhibition that was organised by the Association of Supervising Electrical Engineers in London last month.

We give below the first instalment of short accounts of the more important equipment at Olympia that may be of interest to our readers.

TWO INTERESTING MODELS

An exhibit, which is likely to attract a great deal of attention on the stand of Messrs. C. A. Parsons and Company, Limited, Heaton Works, Newcastle-upon-Tyne, 6, is the model of the 200 MW turbo-alternator, which is illustrated in Fig. 1. As will be seen this is a single line machine, which comprises a high pressure cylinder, an intermediate pressure cylinder and two double flow low pressure cylinders, the latter being coupled to a single generator. The designed steam conditions at the stop valve are 2,350 lb. per square inch and 1,050 deg. F., while re-heating to 1,000 deg. F. is to be used between the high pressure and intermediate pressure cylinders. The final exhaust vacuum will be 28·9 in., and the operating speed 3,000 r.p.m. Visitors to the exhibition will be able to examine the constructional features of this unit on a sectional drawing. Another model is that of a 120 MVA, 132/275 kV auto-transformer for use in connecting the grid and super-grid systems of the Central Electricity Authority.

MINING TRANSFORMER

The same firm is exhibiting the mining transformer which is illustrated in Fig. 2. It consists of a 150 kVA, 3,150/600 volt three-phase unit and has been built to the specification

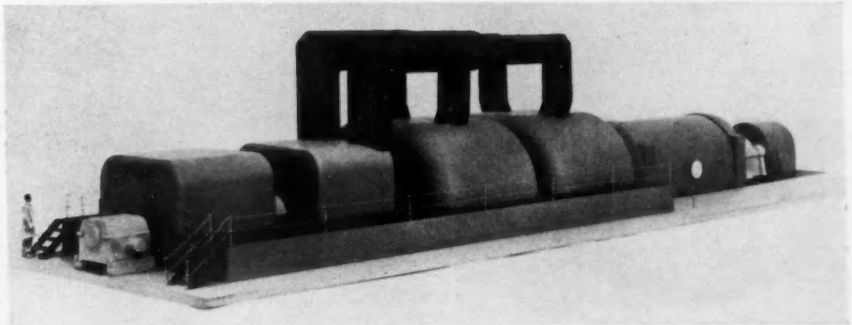


Fig. 1 Model of 200 MW turbo-alternator to operate at 2,350 lb. per sq. in. and 1,050 deg. F.: C. A. Parsons and Co. Ltd.

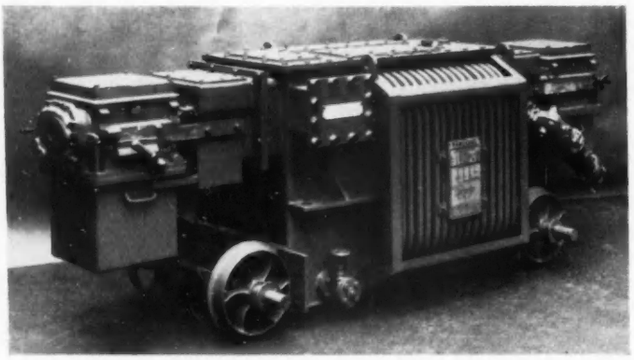


Fig. 2 150 kVA mining type transformer: C. A. Parsons and Co. Ltd.

of the National Coal Board. It is delta-star connected and "U.N." cooled, besides being transportable. Tappings of ±5 and ±10 per cent. are provided on the high tension windings and there is a full output tapping at 475 volt on the low tension winding. These tappings are accessible through hand holes in the tank cover.

A Reyrolle draw-out oil-immersed circuit-breaker, with a rupturing capacity of 25 MVA at 3·3 kV is mounted on an adaptor chamber on the high tension side of the transformer. This breaker is fitted with three over-current trip coils, three inverse time limit dashpots, and one direct-acting earth fault trip coil, as well as a test push button, a resistor and an ammeter. A similar circuit-breaker with a rupturing capacity of 5 MVA at 440 volts is mounted on the low tension side.

The neutral point of the low tension winding is connected to earth through a detachable link which is housed in a flameproof terminal box. The transformer tubes are protected against mechanical damage and the unit is provided with four flanged wheels which can be arranged to suit any rail gauge between 24 in. and 36 in.

The work which Parsons has on hand for nuclear power stations is illustrated on two display stands. One of these shows the plant which is being erected at Calder Hall A, including four 23 MW turbo-alternators with their associated condensers and auxiliaries; eight gas circulators; two "dump" condensers; and the gas duct work for two reactors. The second gives a list of the nuclear power plant for Calder Hall B and Chapelcross power stations.

RURAL TRANSFORMER

An interesting item exhibited by the Transformer Department of Ferranti, Limited, Hollinwood, is the "lock wound core" transformer for rural distribution systems. This core, which is illustrated in Fig. 3, consists of strips of low-loss grain-orientated steel, which are wound into a coil, the overlapping joints being locked in position. As the flux path follows the grain of the steel, and air gaps in the core structure are almost eliminated, both the iron losses and magnetising current are reduced.

Special displays are also being made of a transformer with Class H insulation, so as to show the internal construction of the core and winding; and of scale models of various types of large, medium and distribution transformers, including a model of a 120 MVA, 275 kV unit, several of which are being supplied for the super-grid scheme of the Central Electricity Authority.

Ferranti are further showing a range of indicating and industrial instruments, including the hermetically sealed type. These include a new clip-on wattmeter the movement of which is of the iron-cored dynamometer type. The ranges covered are from 0 to 3 and 0 to 300 kW at voltages up to 600, and either can be selected by a thumb-operated switch. Safety is ensured by substantial insulation throughout the instrument and a high rupturing capacity fuse is incorporated in each of the voltage clips.

DISTURBANCE RECORDER

Another new instrument, which is being shown on this stand, is the disturbance recorder illustrated in Fig. 4. This has been designed to give information in graphic form of faults and disturbances occurring in power stations and on transmission lines and distribution systems. When faults, such as short-circuits from line to earth or between phases, take place the recorder produces a chart showing the state of the system immediately prior to the fault; the nature of the fault; and the magnitude of the fault current. It also shows any change such as a short-circuit from one line to another developing into a symmetrical three-phase fault; the appearance of voltage surges; the behaviour of the protective gear, that is the order in which the various relays have operated; and the time intervals between the beginning of the fault, the operation of the protective relays and the final opening of the circuit-breaker.

The Pegasus electronic computer which Ferranti's are showing is a medium-sized equipment which is suitable for a wide range of applications in the scientific, technical and business fields. Owing to this fact it is simple to programme so that a considerable saving of time can be effected by its use. On the other hand, the new Mercury computer is intended principally for scientific work. Its main characteristic is that all numbers are represented in "floating point" form which involves a great saving in time in carrying out many calculations.

The central feature of the stand of Crompton Parkinson, Limited, Aldwych, London, W.C.2, is a scale model of an industrial trading estate, the object being to demonstrate the part that can be played by the company in carrying out complete industrial electrification projects both at home and abroad. The model, which covers

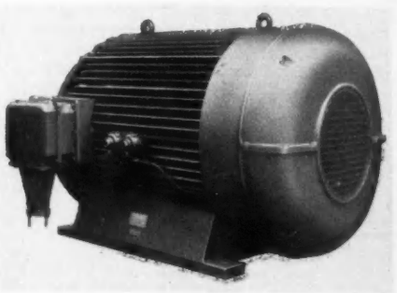


Fig. 5 1½ h.p. solid foot-mounting squirrel cage motor: Crompton Parkinson, Ltd.

about 21 ft. by 10 ft., features a number of important sections of industry such as coal mines and paper and cement mills. Emphasis is also laid on the extent of the equipment involved in providing a supply of electricity from an Area Board's main substation to such an undertaking. Included in the display is a working model of the Crompton Commonwealth type 955 h.p. Diesel-electric locomotive and a typical Diesel-electric shunting locomotive.

As a corollary to this main feature a full range of the firm's products such as generators, transformers, motors, switchgear and lamps is also on view. Typical of the motors is the 1½ h.p. squirrel cage unit with solid foot-mounting, which is illustrated in Fig. 5.

For the first time at any exhibition Crompton's are showing examples of their high efficiency ceiling fans. These have 48 in. diametrical sweeps and are driven by alternating current motors, the exhibit being arranged to demonstrate their quiet running. The fans, which are also made with 56 in. and 60 in. diametrical sweeps, have three sheet aluminium blades, which are specially shaped to produce a large air movement with a minimum power consumption. The motors are of the capacitor type and have two stator windings with a condenser permanently connected in circuit. This design is intended to ensure ample starting torque even with the resistance type regulator in the lowest speed position.

To be continued

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CYLINDER LUBRICANT

For use in marine Diesel engines running on heavy oil, and with the primary intention of reducing cylinder wear, the Shell Petroleum Company, Limited, are now marketing an emulsion-type lubricant, Alexia oil A. Field trials have been in progress for over two years involving 275 ships, and reductions in wear of about 70 per cent. have been obtained.

Fig. 3 "Lock wound core" transformer: Ferranti, Ltd.

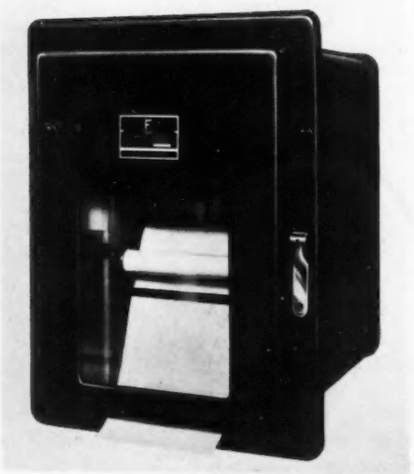

Fig. 4 Disturbance recorder: Ferranti Ltd.

FORTHCOMING EXHIBITIONS AND CONFERENCES

This list, arranged chronologically, appears in the last issue of each month. Events appearing for the first time, and alterations of dates, places, etc., are indicated by an asterisk (*). Particulars of exhibitions and conferences not included below may have appeared in ENGINEERING, *December* 30, *page* 901; *or January* 27, *page* 111. *Organisers are invited to send to the Editor particulars of coming events as soon as arrangements are made.*

***Electrical Association for Women, Annual Meeting.**—Tues. May 1, to Thurs., May 3, at Pier Pavilion, Llandudno. Theme: "Electricity in North Wales." Organised by the Association, 25 Foubert's-place, London, W.1. Tel. GERrard 5212.

Valencia Samples Fair, 34th International.—Tues., May 1, to Sun., May 20, at Valencia. Organised by the Feria Muestrario International de Valencia, Llano del Real 2, Valencia. Information obtainable from the Economic Department, Spanish Embassy, 12 Cadogan-place, London, S.W.1. Tel. SLOane 6181.

Electrical Equipment for Aircraft, Symposium.—Wed., May 2, to Fri., May 4, at the Institution's headquarters. Organised by the Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. Tel. TEMple Bar 7676.

***Bologna International Trade Fair.**—Tues., May 8, to Tues., May 22, at Bologna. Apply to Comm. Umberto Cappelli, Ente Autonomo Fiera, Bologna, Piazza del Francia 1, Bologna, Italy.

***Finnish Industries Spring Fair.**—Fri., May 11, to Mon., May 21, in Helsinki. Apply to the fair offices at Mannerheimintie 17, Helsinki.

***Swedish Industries Fair, International.**—Sat., May 12, to Mon., May 21, at Gothenburg. *Agents:* John E. Buck & Co., 47 Brewer-street, London, W.1. Tel. GERrard 7576.

Physical Society's Exhibition of Scientific Instruments and Apparatus.—Mon., May 14, to Thurs., May 17, at the Royal Horticultural Society's Old and New Halls, Vincent-square, and Greycoat-street, London, S.W.1. Organised by the Physical Society, 1 Lowther-gardens, Prince Consort-road, London, S.W.1. Tel. KENsington 0048.

Applied Spectroscopy, International Colloquium on.—Mon., May 14, to Sat., May 19, at Amsterdam. Apply to Dr. F. Freese, Laboratory of Analytical Chemistry, Nieuwe Achtengracht, Amsterdam c, Holland.

***Scientific Film Association, Conference.**—Wed., May 16, to Fri., May 18, at Ashorne Hill, near Leamington Spa. Theme: "Film as an Aid to Management." Organised by the Association, 164 Shaftesbury-avenue, London, W.C.2. Tel. TEMple Bar 4694.

***Incorporated Plant Engineers, Annual Conference.**—Wed., May 16, to Fri., May 18, at the Hotel Majestic, Harrogate. Organised by the Incorporated Plant Engineers, 48 Drury-lane, Solihull, Warwickshire. Tel. Solihull 3021.

"Habitation 56."—Sat., May 19, to Sun., June 3, corner of Boulevard General Wahis and Avenue Leopold III, Brussels. Combined home and building exhibition, sponsored by the Brussels Chamber of Commerce Building Group. *Agents:* Willoughby and Young, 6a Smith-street, London, S.W.3. Tel. SLOane 1594.

Production Exhibition.—Wed., May 23, to Thurs., May 31, at Olympia, London, W.14. Organised by Andry Montgomery Ltd., 32 Millbank, London, S.W.1. Tel. TATe Gallery 8134.

Mediterranean Fair, Eleventh.—Fri., May 25, to Sun., June 10, at Palermo. Organised by the Fiera del Mediterraneo, Piazza General Cascino, Palermo, Italy.

Packaging Salon, Fifth International; and 34th International Fair.—Tues., May 29, to Wed., June 13, at Padua. *Agents:* Italian Chamber of Commerce for Great Britain and British Commonwealth, 652 Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 5521.

Vapour Phase Chromatography.—Wed., May 30, to Fri., June 1, in London. Organised by the Hydrocarbon Research Group of the Institute of Petroleum, 26 Portland-place, London, W.1. (Tel. LANgham 2250.) Apply to the organising secretaries: Mr. D. M. Desty and Mr. H. C. Rampton, the Research Station, British Petroleum Co., Ltd., Sunbury-on-Thames.

Bath and West Agricultural Show.—Wed., May 30, to Sat., June 2, at Cardiff. Organised by the Bath and West and Southern Counties Society, 3 Pierrepont-street, Bath. Tel. Bath 3010.

High Tension Networks, 16th International Conference on.—Wed., May 30, to Sat., June 9, at the Fondation Berthelot, 28 Rue Saint Dominique, Paris. Organised by the Conférence Internationale des Grands Réseaux Electriques. Apply to British Committee, Thorncroft Manor, Leatherhead.

Barcelona Samples Fair, 24th International.—Fri., June 1, to Wed., June 20, at Barcelona. Apply to the Spanish Tourist Service, 4 West Halkin-street, Belgrave-square, London, S.W.1. Tel. SLOane 6124; or to the Economic Department, Spanish Embassy, 12 Cadogan-place, London, S.W.1. Tel. SLOane 6181.

***Atoms, Electrons and Industry Exhibition.**—Wed., June 6, to Fri., June 8, at the Royal West of England Academy, Bristol. Organised by the Electronics Section, Scientific Instrument Manufacturers' Association of Great Britain, 20 Queen Anne-street, London, W.1. Tel. LANgham 4251. Admission free, by ticket.

Light Metals Convention, Third International.—Thurs., June 7, to Sat., June 9, at the Montanistische Hochschule, Leoben, Austria. Information obtainable from the organising committee, Institut für Metallkunke, Montanistische Hochschule, Leoben, Steiermark, Austria.

Molecular, Structure and Spectroscopy, Annual Symposium.—Mon. June 11, to Fri., June 15, at Columbus, Ohio. U.S.A. Apply to the secretariat, Department of Physics, Ohio State University, Columbus, Ohio, U.S.A.

Spectroscopy, Fourth Meeting of Joint Commission on.—Mon., June 11, to Fri., June 15, at Columbus, Ohio, U.S.A. Organised by the International Council of Scientific Unions. Apply to the secretary, Joint Commission on Spectroscopy, Zeeman Laboratorium, Plantage Muidergracht 4, Amsterdam Holland.

World Power Conference, Fifth Plenary.—Sat., June 16, to Sat., June 23, in Vienna. Organised in Austria by the Oesterreichischen Nationalkomitees der Weltkraftkonferenz Schwarzenbergplatz 1, Vienna 1. Apply to Mr. C. H. Gray, secretary, World Power Conference, 201–202 Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 3966. See ENGINEERING, February 11, 1955, page 168, and February 25, 1955, page 249.

***Building and Public Works Exhibition, Second.**—Sat., June 16, to Thurs., June 28, in Paris. *Agent:* R. C. Leibman, 178 Fleet-street, London, E.C.4. Tel. CITy 5889.

American Society for Testing Materials.—*Annual Meeting:* Sun., June 17, to Fri., June 22, at Atlantic City, N.J. Held in association with the Exhibit of Testing and Scientific Apparatus. *Pacific Coast National Meeting:* Sun., Sept. 16, to Sat., Sept. 22, at the Hotel Statler, Los Angeles, Calif. Offices of the Society: 1916 Race-street, Philadelphia 3, Pa., U.S.A.

Testing and Scientific Apparatus and Laboratory Supplies, 12th Exhibit of.—Sun., June 17, to Fri., June 22, at Atlantic City, N.J. Organised by the American Society for Testing Materials in connection with their Annual Meeting. Offices of the Society: 1916 Race-street, Philadelphia 3, Pa., U.S.A.

Civil Engineering Problems in the Colonies, Conference.—Mon., June 18 to Fri., June 22, at Institution of Civil Engineers, Great George-street, London, S.W.1. Apply to the Secretary of the Institution at that address. Tel. WHItehall 4577.

Acoustics, Second Congress of International Commission on.—Mon., June 18, to Sun., June 24, at Cambridge, Mass., U.S.A. Apply to Professor P. Fleury, International Union of Pure and Applied Physics, 3 Boulevard Pasteur, Paris 15e.

***Automation, International Congress on.**—Mon., June 18, to Sun., June 24, at the Conservatoire National des Arts et Métiers, 292 Rue Saint-Martin, Paris, 3ème. Apply to the Congress Secretariat at that address.

***Manufacture of Paper and Associated Materials for Illustration Work, Fifth International Exhibition.**—Fri., June 22, to Sat., June 30, in Paris. Apply to the secretary-general, Salon International des Techniques Papetières et Graphiques, 40 Rue du Colisée, Paris, 8e.

Machine Tool Exhibition, International.—Fri., June 22, to Fri., July 6, at Olympia, London, W.14. Organised by the Machine Tool Trades Association, Victoria House. Southampton-row, London, W.C.1. Tel. HOLborn 4667.

Trieste International Trade Fair, Eighth.—Sun., June 24, to Sun., July 8, at Trieste. *Agents:* Italian Chamber of Commerce for Great Britain and British Commonwealth, 652 Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 5521.

Colonial Highways Problems, Round Table Conference on.—Mon., June 25, to Wed., June 27, at the Institution of Civil Engineers, Great George-street, London S.W.1. Organised in conjunction with the Colonial Office. Apply to the secretary of the Institution at the above address. Tel. WHItehall 4577.

International Association of Bridge and Structural Engineering, Fifth International Congress.—Mon., June 25, to Mon. July 2, at Lisbon, Portugal. Apply to Mr. L. Gretener, secretary of the Association, Swiss Federal Institute of Technology, Zürich, Switzerland. (Alteration of dates.)

***Cybernetics Congress.**—Tues., June 26, to Fri., June 29, at Namur, Belgium. Sections on Automation and Mechanical Brains. Organised in co-operation with the Belgian Ministry of Education and U.N.E.S.C.O. Apply to the Commercial Department, Belgian Embassy, 103 Eaton-square, London, S.W.1. Tel. SLOane 9271.

Glass Congress, Fourth International.—Commencing Mon., July 2, at Paris. Apply to the secretary, Institut du Verre, 24 Rue Dourlet, Charleroi, Belgium.

International Union of Forest Research Organisations, 12th International Congress.—Fri., July 6, to Sat., July 14, at Oxford. Apply to Professor A. de Philippis, Instituto di Selvicoltura, Piazzale delle Cascine, Florence, Italy.

New York Lamp Show.—Sun., July 8, to Fri., July 13, at New Yorker Hotel, New York. Apply to Mr. George F. Little, 220 Fifth-avenue, New York 1.

Duke of Edinburgh's Study Conference on Human Problems of Industrial Communities within the Commonwealth and Empire.—Mon., July 9, to Fri., July 27, at Oxford.

Great Yorkshire Agricultural Show.—Tues., July 10 to Thurs., July 12, at Harrogate. Organised by the Yorkshire Agricultural Society, Cliftonfield, Shipton-road York. Tel. York 3102.

Molecules in Cosmic Sources, Seventh International Astrophysical Symposium on.—Thurs. July 12 to Sat. July 14, at Liège, Belgium. Apply to Prof. Harold C. Urey, Institute for Nuclear Studies, University of Chicago, Chicago 27, Ill., U.S.A.

Industrial Co-Partnership Association's 26th Summer Conference.—Fri., July 13, to Mon., July 16, at Girton College, Cambridge. Apply to the Industrial Co-Partnership Association, 36 Victoria-street, London, S.W.1. Tel. ABBey 3342.

International Society of Photogrammetry, Eighth Congress.—Tues., July 17, to Thurs., July 26, at Stockholm. Apply to Mr. P. O. Fagerholm, Bragevägen 8, Stockholm, Sweden.

Housing and Town Planning, International Congress.—Sun., July 22, to Sat., July 28, at Vienna. Apply to Mr. H. van der Weijde, secretary-general to the Federation of Housing and Town Planning, Paleisstraat 5, The Hague, Holland.

Royal Welsh Agricultural Show.—Wed., July 25 to Fri., July 27, at Rhyl. Apply to the secretary, the Royal Welsh Agricultural Society, Queen's-road, Aberystwyth. Tel. Aberystwyth 7551.

Australian World's Fair.—Thurs., July 26, to Sat., Aug. 4, at Sydney. Apply to the managing director, Australian World's Fair, 234 Clarence-street, Sydney, N.S.W., Australia.

***Skane (Swedish National) Fair.**—Sat., July 28, to Sun., Aug. 5, at Malmo. Apply to Skanemassan Kommissariat, Stora Nygatan 15, Malmo, Sweden.

***X-Ray Microscopy and Microradiography, Symposium on.**—Thurs., Aug. 16, to Tues., Aug. 21, at the Cavendish Laboratory, Cambridge. Held under the auspices of the Non-Destructive Testing Group, Institute of Physics. Apply to the organiser, Dr. W. C. Nixon, Cavendish Laboratory, Cambridge. Tel. Cambridge 55478.

British Association Meeting.—Wed., Aug. 29, to Wed., Sept. 5, in Sheffield. Apply to the secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1. Tel. REGent 2109.

Foundry Trades Fair, International (GIFA).—Sat., Sept. 1, to Sun., Sept. 9, at the Fair Halls, Düsseldorf. To be held in connection with the 23rd International Foundry Congress. Organised by the Nordwestdeutsche Ausstellungs-Gesellschaft m.b.H. (NOWEA), Ehrenhof 4, Düsseldorf, Germany. *Agents:* John E. Buck & Co., 47 Brewer-street, London, W.1. Tel. GERrard 7576. See ENGINEERING, October 21, 1955, page 565.

Strasbourg European Fair, 31st.—Sat., Sept. 1, to Sun., Sept. 16, at Strasbourg. *Agent:* R. C. Liebman, 178 Fleet-street, London, E.C.4. Tel. CITy 5889.

***St. Erik's Fair.**—Sat., Sept. 1, to Sun., Sept. 16, at Stockholm. *Agents:* Thirza West Publicity Ltd., 141 New Bond-street, London, W.1. Tel. MAYfair 3701.

Frankfurt International Autumn Fair.—Sun., Sept. 2, to Thurs., Sept. 6, at Frankfurt. *Agents:* Lep Transport, Ltd., Sunlight Wharf, Upper Thames-street, London, E.C.4. Tel. CENtral 5050.

Applied Mechanics, Ninth International Congress.—Wed., Sept. 5, to Thurs., Sept. 13, at Brussels. Apply to the general secretariat, Université Libre de Bruxelles, 50 Avenue F. D. Roosevelt, Brussels, Belgium.

***Swiss National Autumn Fair (Comptoir Suisse).**—Sat., Sept. 8, to Sun., Sept. 23, at Lausanne. Apply to the commercial secretary, Swiss Legation, 18 Montague-place, Bryanston-square, London, W.1. Tel. PADdington 0701.

German Agricultural Show.—Sun., Sept. 9, to Sun., Sept. 16, at Hanover. Apply to the Deutsche Landwirtschafts-Gesellschaft, Niedenau 48, Frankfurt-on-Main.

Electron Transport in Metals, Symposium on.—Mon., Sept. 10, to Fri., Sept. 14, at Ottawa, Canada. Apply to Professor P. Fleury, International Union of Pure and Applied Physics, 3 Boulevard Pasteur, Paris 15e.

Fatigue of Metals Conference.—Mon., Sept. 10, to Fri., Sept. 14, in London. Organised by the Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. Tel. WHItehall 7476.

***Utrecht International Autumn Fair.**—Tues., Sept. 11, to Thurs., Sept. 20, at Utrecht. *Agent:* Mr. W. Friedhoff, 10 Gloucester-place, London, W.1. Tel. WELbeck 9971.

Building Plant Exhibition.—Wed., Sept. 12, to Wed., Sept. 19, at the D and E Car Parks, Gosforth Park Racecourse, Great North-road, Newcastle-upon-Tyne. Organised by the Ministry of Works, Lambeth Bridge House, London, S.E.1. Tel. RELiance 7611.

Static Electricity in Textiles, Overseas Conference on.—Thurs., Sept. 13, to Mon., Sept. 17, at Zürich. Apply to the general secretary, Textile Institute, 10 Blackfriars-street, Manchester 3.

Function and Education of Welding Engineers, Conference on.—In mid-September. Organised by the Institute of Welding. 2 Buckingham Palace-gardens, London, S.W.1. Tel. SLOane 9851.

***Marseilles International Fair.**—Sat., Sept. 15, to Mon., Oct. 1, at Marseilles. *Agents:* Butlers Advertising Service, 22 St. Giles High-street, London, W.C.2. Tel. TEMple Bar 5905.

***British Road Federation's International Conference.**—Mon., Sept. 17, to Thurs., Sept. 20, at Friends House, Euston-road, London, N.W.1. Theme: "Urban Motorways." Organised by the British Road Federation, 26 Manchester-square, London, W.1. Tel. WELbeck 0221.

***Association of Public Lighting Engineers, Annual Conference.**—Tues., Sept. 18, to Fri., Sept. 21, at Winter Gardens, Blackpool. Exhibition of Street Lighting Apparatus and Equipment at Winter Gardens, and Outdoor Display of Lamp Columns and Mobile Equipment in the Middle Walk Promenade. Organised by the Association of Public Lighting Engineers, 17 Victoria-street, London, S.W.1. Tel. ABBey 4281.

***Plastic Theory of Structures, Symposium on.**—Tues., Sept. 18, to Fri., Sept. 21, at Clare College, Cambridge. Organised by the Department of Engineering, University of Cambridge, Engineering Laboratory, Trumpington-street, Cambridge. Tel. Cambridge 55691.

Physical Chemistry of Processes at High Pressures, Conference.—Thurs. and Fri., Sept. 20 and 21, at Glasgow. Apply to the secretary, Faraday Society, 6 Gray's Inn-square, London, W.C.1. Tel. CHAncery 8101.

Commercial Motor Transport Exhibition, International.—Fri., Sept. 21, to Sat., Sept. 29, at Earl's Court, London, S.W.5. Organised by the Society of Motor Manufacturers and Traders, Ltd., 148 Piccadilly, London, W.1. Tel. GROsvenor 4040.

Science of Photography, International Conference on.—Mon., Sept. 24, to Thurs., Sept. 27, at Cologne. Apply to Dr. Walter Schürmeyer, Deutsche Gesellschaft für Photographie e.v., Hohenstaufenring 48/54, Cologne, Germany.

***Brussels Colonial Exhibition.**—Sat., Sept. 29, to Sun., Oct. 14, in Brussels. Apply to Foire Coloniale de Bruxelles, 20-21 Boulevard Baudouin, Brussels.

***Agricultural Engineering Exhibition, Eighth International.**—Sat., Sept. 29, to Sun., Oct. 14, at Turin. Part of the Sixth International Technical Exhibition in this city. Apply to the exhibitions secretary, Via Massena, Turin.

***Metz International Fair.**—Sat., Sept. 29, to Mon., Oct. 15, at Metz. *Agents:* Auger and Turner Group, Ltd., Autur House, 40 Gerrard-street, London, W.1. Tel. GERrard 6671.

***Fuel Efficiency Exhibition.**—Tues., Oct. 2, to Wed., Oct. 10, at Olympia, London, W.14. Organised by Provincial Exhibitions Ltd., in Association with F. W. Bridges and Sons, Ltd. Apply to the public relations officer, 9 Southampton-place, London, W.C.1. Tel. CHAncery 2131.

Chemists' Trade Fair, International (INDROFA).—Sun., Oct. 7, to Sun., Oct. 14, at Düsseldorf. Organised by the Nordwestdeutsche Ausstellungs-Gesellschaft m.b.H. (NOWEA), Ehrenhof 4, Düsseldorf, Germany.

***"Vochema" International Fair.**—Tues., Oct. 9, to Wed., Oct. 17, at Utrecht. Comprises machinery and equipment for the food industry, and the chemical and pharmaceutical industry. *Agent:* W. Friedhoff, 10 Gloucester-place, London, W.1. Tel. WELbeck 9971.

Motor Show (41st International Motor Exhibition).—Wed., Oct. 17, to Sat., Oct. 27, at Earl's Court, London, S.W.5. Organised by the Society of Motor Manufacturers and Traders, Ltd., 148 Piccadilly, London, W.1. Tel. GROsvenor 4040.

***Application of Low-Alloy Steels for Welded Pressure Vessels, Symposium on.**—Fri., Oct. 19, at 39 Elmbank-crescent, Glasgow, C.2. All-day conference, organised by the West of Scotland Iron and Steel Institute, 39 Elmbank-crescent, Glasgow, C.2. Tel. Central 5181.

***Dairy Equipment Exhibition.**—Sat., Nov. 3, to Mon., Nov. 12, in Paris. Apply to the Commissaire-General, Salon International de l'Equipement Laitier, 28 Rue Louis-le-Grand, Paris, 2e.

Cycle and Motor Cycle Show, 31st International.—Sat., Nov. 10, to Sat., Nov. 17, at Earl's Court, London, S.W.5. Organised by the British Cycle and Motor Cycle Manufacturers' and Traders' Union, Ltd., The Towers, Warwick-road, Coventry (Tel. Coventry 62511); and 20-23 Lincoln's Inn Fields, London, W.C.2. Tel. CHAncery 4152.

Public Works and Municipal Services Congress and Exhibition.—Mon., Nov. 12, to Sat., Nov. 17, at Olympia, London, W.14. Organised by the Municipal Agency, Ltd., 70 Victoria-street, London, S.W.1. Tel. VICtoria 9132.

Smithfield Show and Agricultural Machinery Exhibition.—Mon., Dec. 3, to Fri., Dec. 7, at Earl's Court, London, S.W.5. Apply to the exhibition manager, Smithfield Show Joint Committee, 148 Piccadilly, London, W.1. Tel. GROsvenor 4040.

THE HUMAN ELEMENT

Pay rates at atomic energy establishments—Workers in the motor industry want a hand in shaping policy—Annual conference of the Scottish T.U.C.—Effect of new machines in coal mines—Experience of work study—National Insurance for research students.

★ ★ ★

Atomic Energy Workers

The Atomic Energy Authority have over 20,000 people on their payroll, working in eleven establishments. The numbers are rising by about 6 per cent. per annum and are eventually expected to total about 30,000. There will be a tendency for the constitution of the labour force to change, from construction workers required when the establishments are being built, to operatives and maintenance men when that phase is over.

A claim for increased wages was made about two months ago by the unions involved and has been discussed by the National Joint Council for the Atomic Energy Industry, on which sit representatives of the A.E.A. and of the unions. Last month the A.E.A. offered £7 13*s.* a week for unskilled men and £9 6*s.* for skilled men, but the union counterclaimed at basic rates of £8 5*s.* and £10, respectively. Among the unions represented on the Joint Council are the General Workers, the Municipal Workers, the A.E.U., the E.T.U., builders, metalworkers and boilermakers. The Authority's offer is considered inadequate for the nature of the work and there is some resentment that the wage levels in the industry should be related to those in the heavy chemical industry. There are at present wide variations in the rates paid from establishment to establishment, and the men want to bring about greater uniformity.

The Authority have so far found little difficulty in recruiting locally most of the men they require, perhaps because a high degree of overtime is generally worked. The special rates of pay which the industry's special position makes permissible provide an opportunity for a rational wages structure which is far too good to miss. Many of the older industries, employers and unions alike, would envy this freedom.

★ ★ ★

Vehicle Shop Stewards and the Future

The much-heralded meeting of the motor industry shop stewards representing 150,000 workers in the "Big Five" motor companies was held in Coventry last Sunday. The 200 representatives considered their attitudes to short-time and automation and the statement issued after the meeting showed that more discussion is required before a coherent policy can be evolved.

The shop stewards of the Standard Motor Company called for negotiations with the managements on the question of allotting the savings likely to accrue from the introduction of automatic machinery. One third should be management's for development and profits, one third should go to reduce the prices of the industry's products, and one third to finance a progressive reduction in the hours worked. The last part of this resolution was opposed, however, and it was withdrawn.

Among the resolutions passed unanimously was one calling for a conference of the officials of the Confederation of Shipbuilding and Engineering Unions to consider problems arising from the introduction of new machinery and new techniques. There is evidence that the unions are seriously concerned with the price levels of cars and tractors, which they want reduced or maintained, and with the level of expenditure on research and development. Another resolution called for the nationalisation of the industry, on the grounds that this is the only means of achieving long-term full employment. Feeling ran high on the subject of redundancy and short time, and the Confederation were requested to undertake a vigorous campaign for a 40 hour week without loss of pay. The call for a full and detailed inquiry into the motor industry, with trade-union representation, was made once more and the Government were left in no doubt concerning the shop stewards' attitudes concerning the credit squeeze, hire purchase restrictions and purchase tax.

The motor industry's workers are evidently much more worried about the future of their industry than the companies themselves. Many of their demands could, if granted, result in the active participation of organised labour in policy making. It is open to question whether or not this development can be achieved without eliminating competition from the industry—hence, presumably, the call for nationalisation.

★ ★ ★

Gleam in the North

The 59th annual conference of the Scottish Trades Union Congress which was held last week lacked neither good subjects for debate (it opened the day after the Budget) nor forthrightness in comment. In the days of the late James Elgar the proceedings of the Scottish T.U.C. were well-ordered affairs with Smith Square and Glasgow clearly in rapport. These days the Scottish T.U.C. is more inclined to go its own way—on the surface at any rate.

It was clear at last week's debates that the delegates liked neither the Budget nor the idea of wage restraint. Later on in the proceedings they showed a distinct liking for the 40 hour week. A vigorous campaign to achieve this long-sought goal of organised labour was approved and some distaste of overtime "in order to live" was also expressed. To some extent, the meeting at Perth last week was a sign of the growing militancy of the trade-union movement. There are other factors to take into account, however. Allowance must be made for the contentious streak in the national character north of the border and the pleasure which a Scottish trade-union organisation can extract from twisting the tail of a Tory Government in London. To some extent all this is a dig at "the auld enemy." It should be recalled that much of the fire and rebellion of Clydeside in the twenties and thirties was softened by the soothing atmosphere of Westminster. Nevertheless, the Scottish T.U.C's retort to the Budget was more than cool. One might have expected something a little warmer for a Macmillan.

★ ★ ★

Automation in Coalmining

The mining of 600 tons a day with one machine operated by three or four men is now thought to be a practical proposition in the fairly near future. The automation of coal cutting and loading lies within the bounds of possibility. This hope, of course, pre-supposes the type of seam which can be worked with a cutter-loader or with a coal plough. There is at Mansfield colliery in the East Midlands division of the National Coal Board a 25 ft. length of coal face which may be the most highly mechanised in the world. An automatic cutter-loader, which is an improved type of Trepanner machine, is operated in conjunction with a self-advancing roof support system, the Dowty "Roofmaster," which is described in an article on page 275.

The use of the Trepanner on a 200 yard strip makes possible an output of 420 to 450 tons a day from a seam 3 ft. 2 in. thick with 60 men (required mainly to advance the roof supports) compared to 400 tons a day with 80 to 90 men when using an ordinary coal cutter, shot firing and hand filling. It may now be possible to develop the walking-prop system to work seams 2 ft. 2 in. in depth which can be cut at a single passage of a coal plough and which are very difficult to work by hand. If the roof support system can be mechanically advanced more rapidly than by hand, as is fully expected, [illegible] cuts a day will be made instead of the [illegible] cuts if the props and steel support bars are [illegible] handled. This could give an output of [illegible] 600 tons a day, an improvement of at least one third, and would reduce the number of men required to about half a dozen.

The development of these new techniques and machines is at too early a stage to assess the coal-face miner's reactions to these savings in labour. But the shortage of men with the skill and experience required, and the dangerous and unpleasant working conditions at the face, suggest that the new developments might be welcomed by all concerned.

★ ★ ★

Work Study Again

It was announced last week that the British Transport Commission are to establish a work study division, once more underlining the progress which this technique is making in the large, basic industries. The same week saw one of the authorities on the subject issue a warning that work study is not a formula for all management ills. This rapid progress with work study, accompanied by a due humility on the part of its exponents, is a healthy development.

A useful and brief pamphlet on the subject has been issued by the Bristol and Bath Productivity Association (price 3*s.*) called "What About Work Study?" It has two merits in particular. First, it deals with some of the snags attendant on using work-study techniques—and this is important for these techniques have to be applied to concerns which are already complex with precedents and human attitudes. Second, it deals with case studies; here a few well chosen cases are worth a volume of principles and abstractions—important as these last are in their right place. Work study is the application of the scientific method to situations which have all too often been bedeviled by bargaining compromises with operatives, with little regard to the job on hand, empire building by heads of departments and preconceived notions and traditions at the top. This kind of breeding ground of inefficiency can be removed only by objective study and diplomatic presentation of the case for change.

★ ★ ★

Insurance for Research Students

The Government have now decided that research students holding post-graduate awards shall normally be treated as in full-time education: they may be excepted, if they so wish, from the payment of contributions under the National Insurance scheme. This decision was announced by the Minister of Pensions and National Insurance in the House of Commons last week. It is an excellent example of the left hand not knowing what the right hand is doing.

At present, students up to their eighteenth birthday are credited with National Insurance contributions. From then on they can choose whether they will pay contributions at the "non-employed" rate, which is 6*s.* 6*d.* for men and rather less for women. Since some students are unable to pay during their courses they are allowed to do so at any time within approximately four years of the end of their course. The research student, whether working on a grant on a specific piece of research or preparing for one of the higher degrees, is therefore, from the point of view of the insurance scheme, either self-employed or unemployed.

This has a strange ring about it at a time when the country is supposed to be desperately short of skilled men and is prepared to spend millions of pounds a year on providing new facilities for technical training. The likelihood of a good man being out of work and in need of insurance cover while his grant lasts is small but he needs an adequate sense of security if he is to do good work and gravitate afterwards into a job where his training can yield the greatest possible benefit to himself and the community, rather than having to take the first thing that comes along.

Parting...Tapering...Sealing

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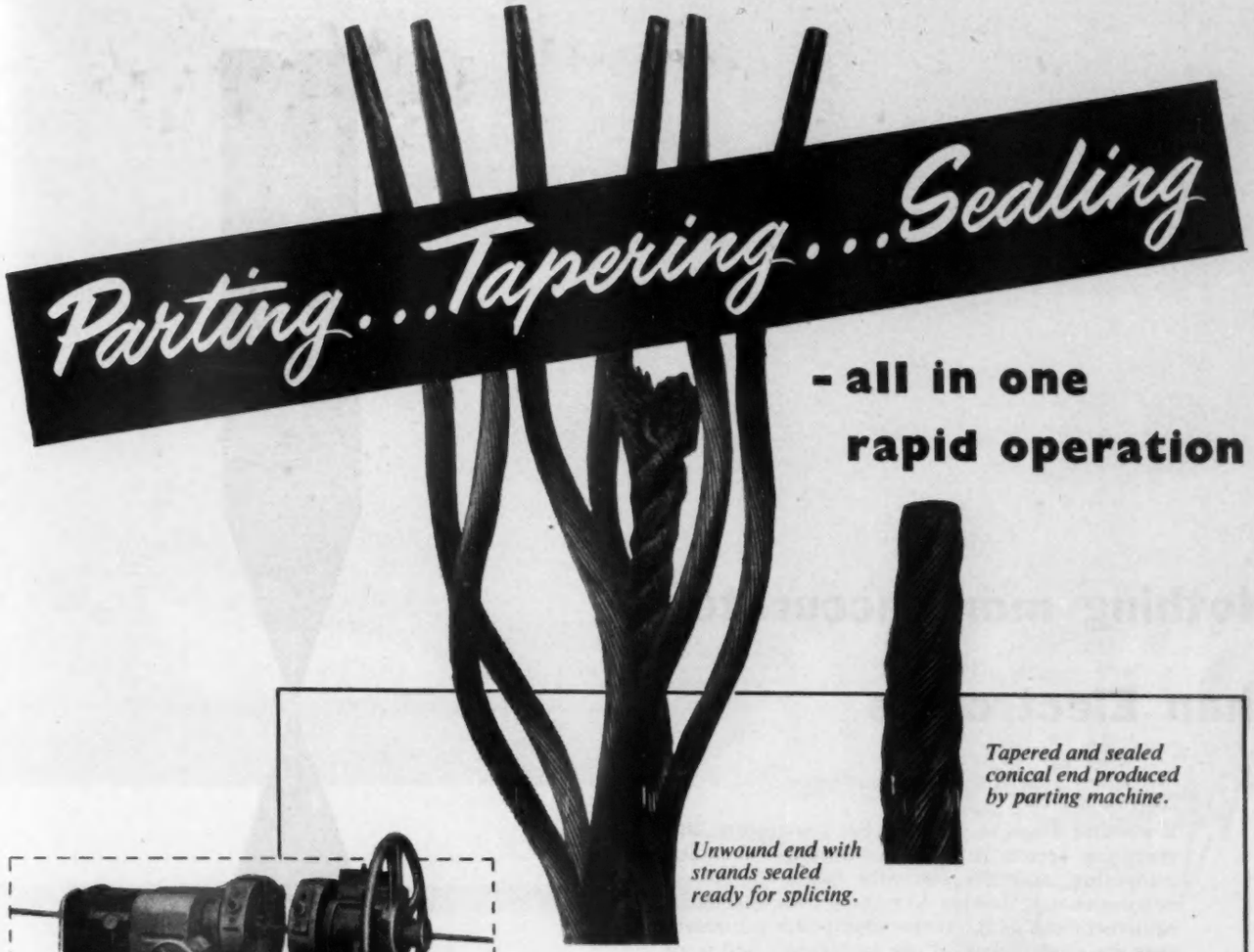
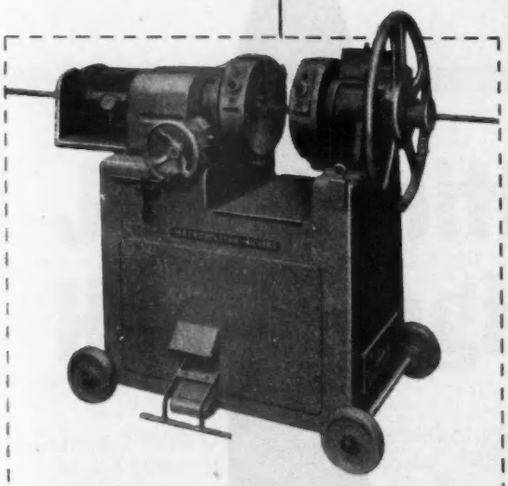


Tapered and sealed conical end produced by parting machine.

Unwound end with strands sealed ready for splicing.



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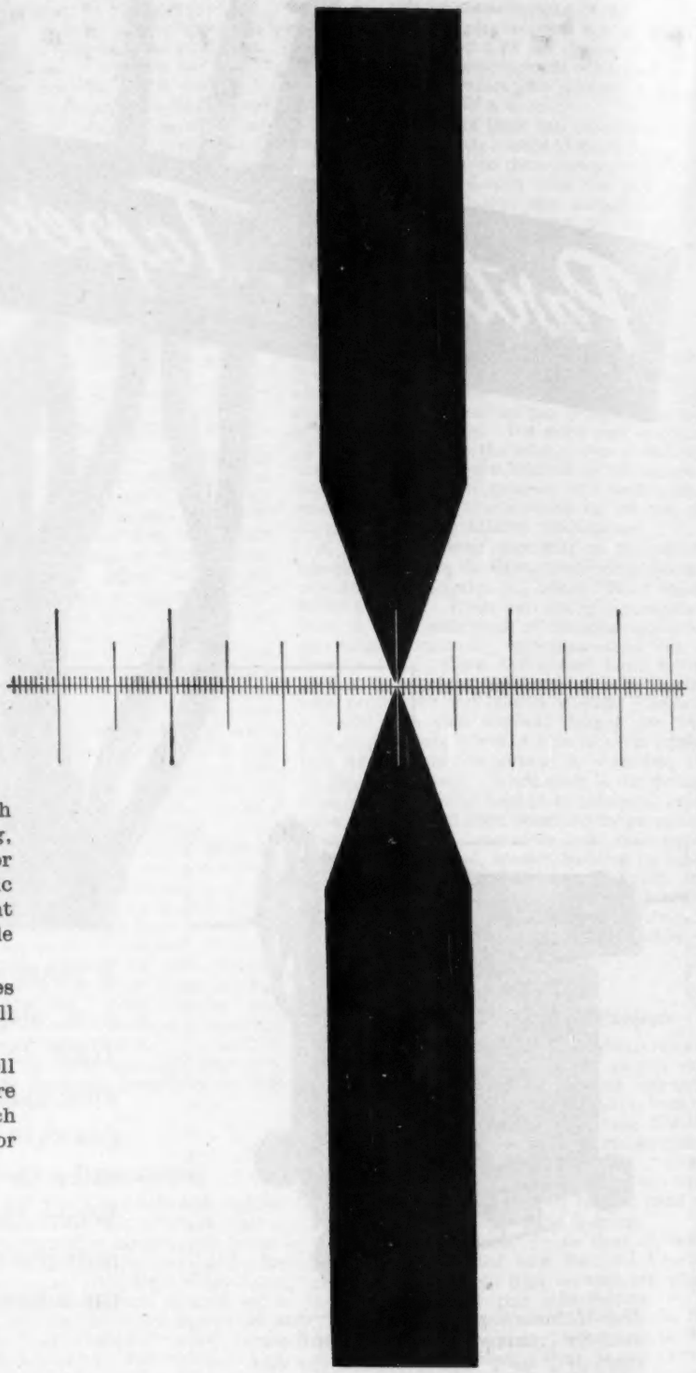

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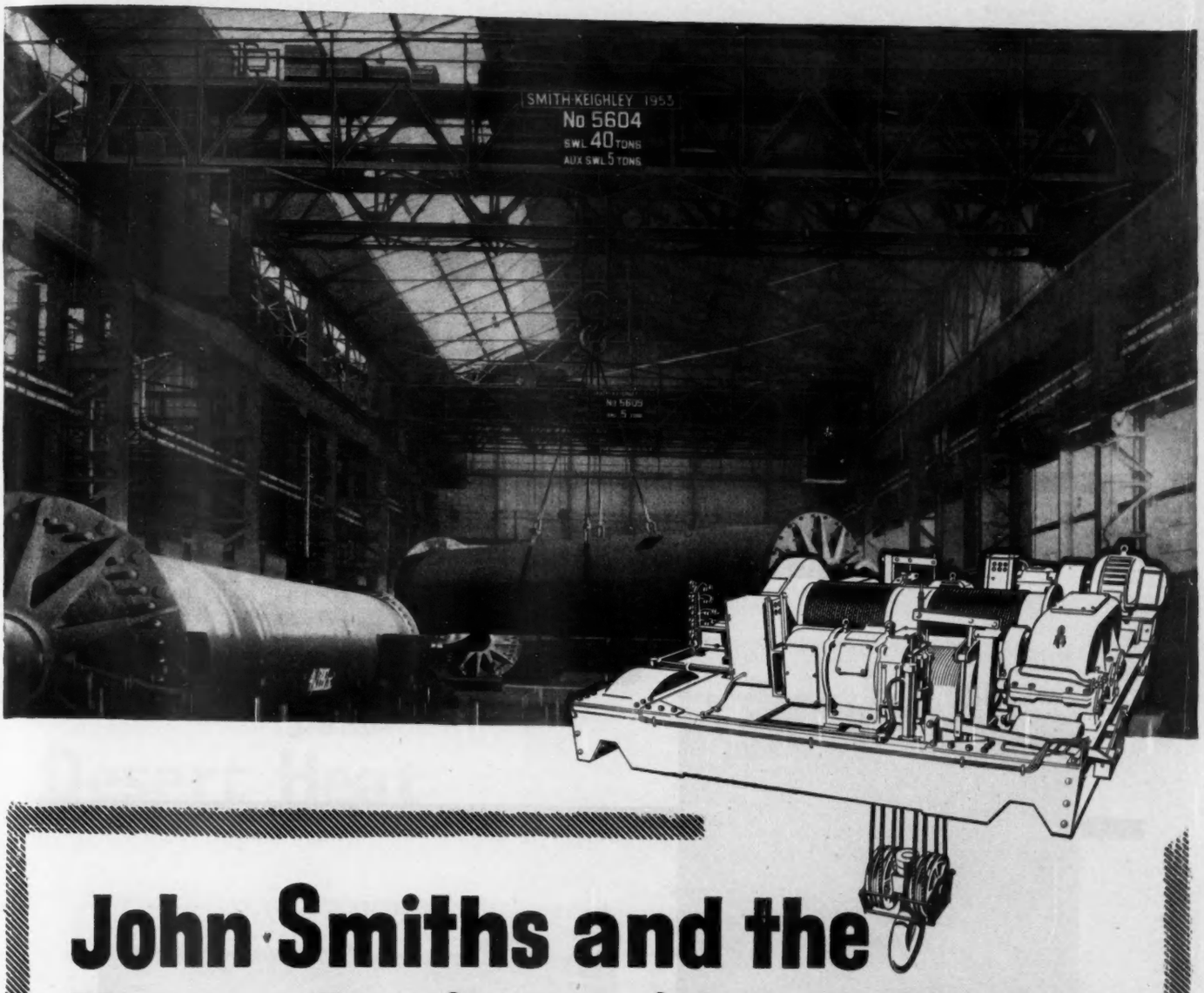

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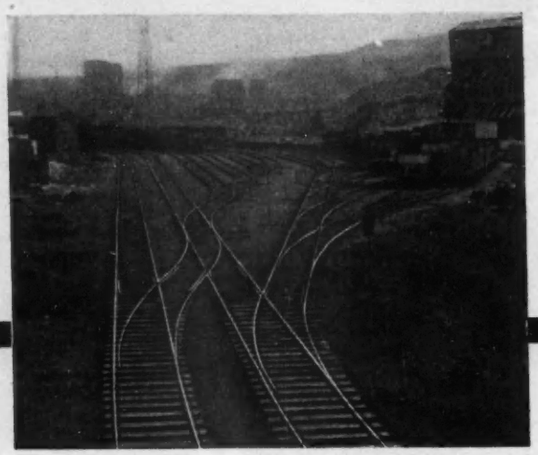

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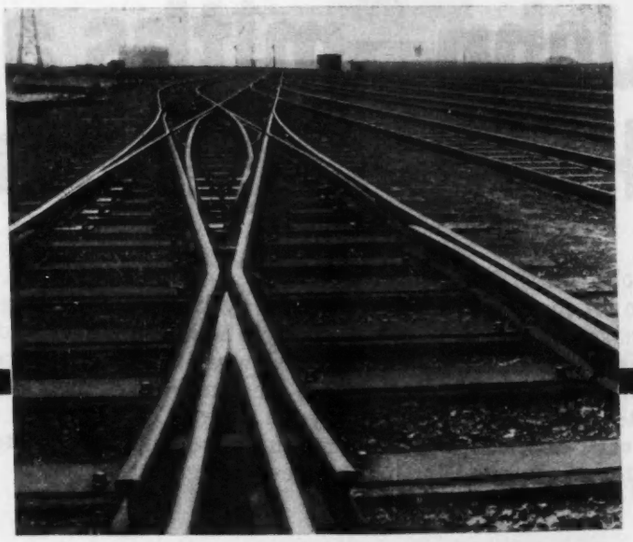

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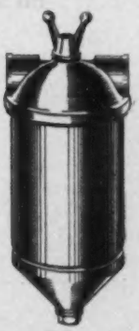

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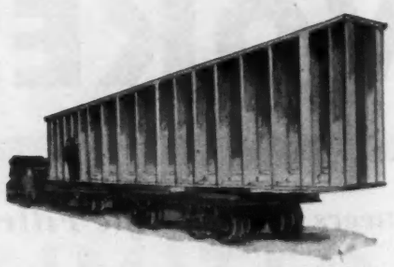

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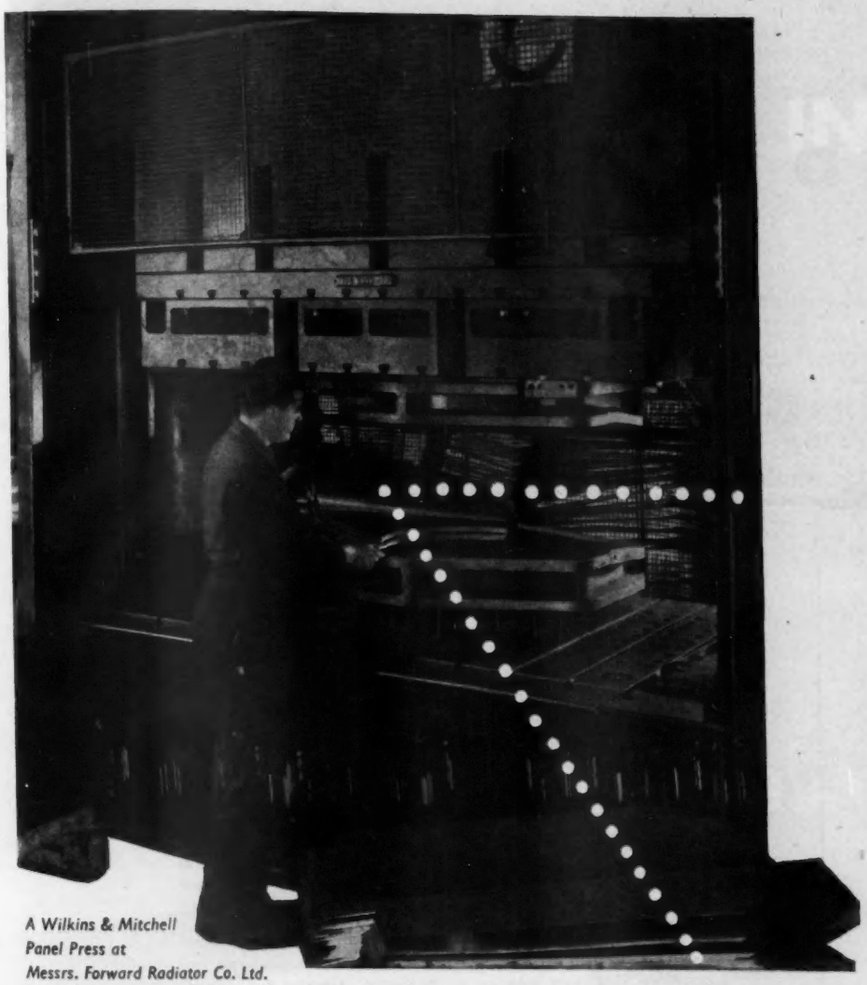

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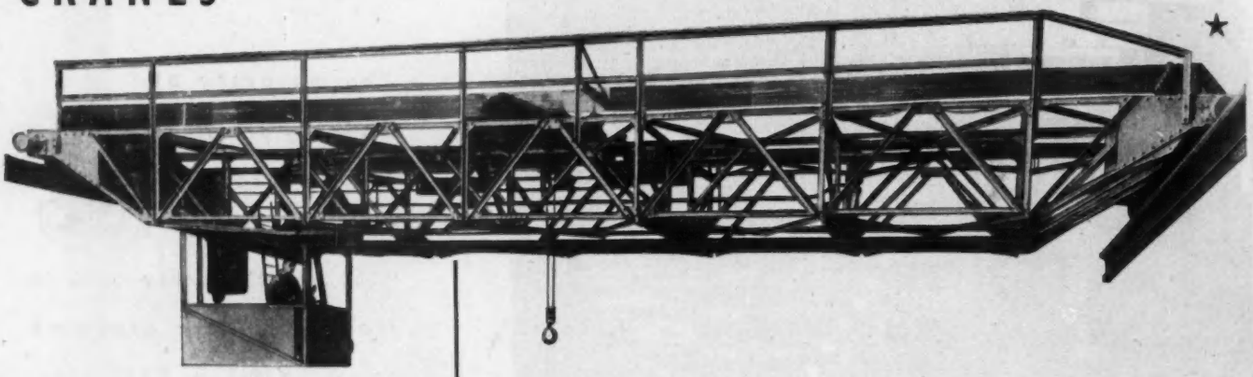

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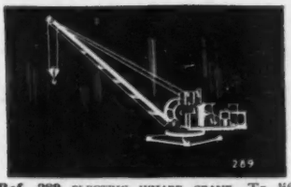

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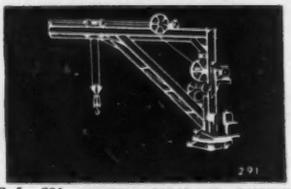

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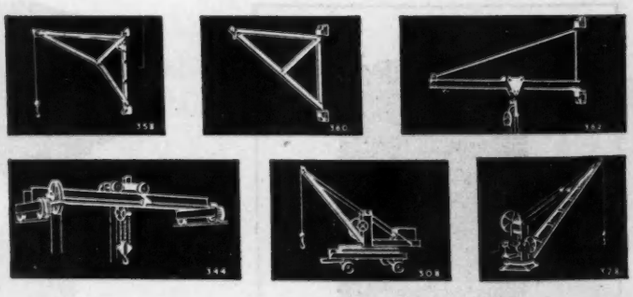

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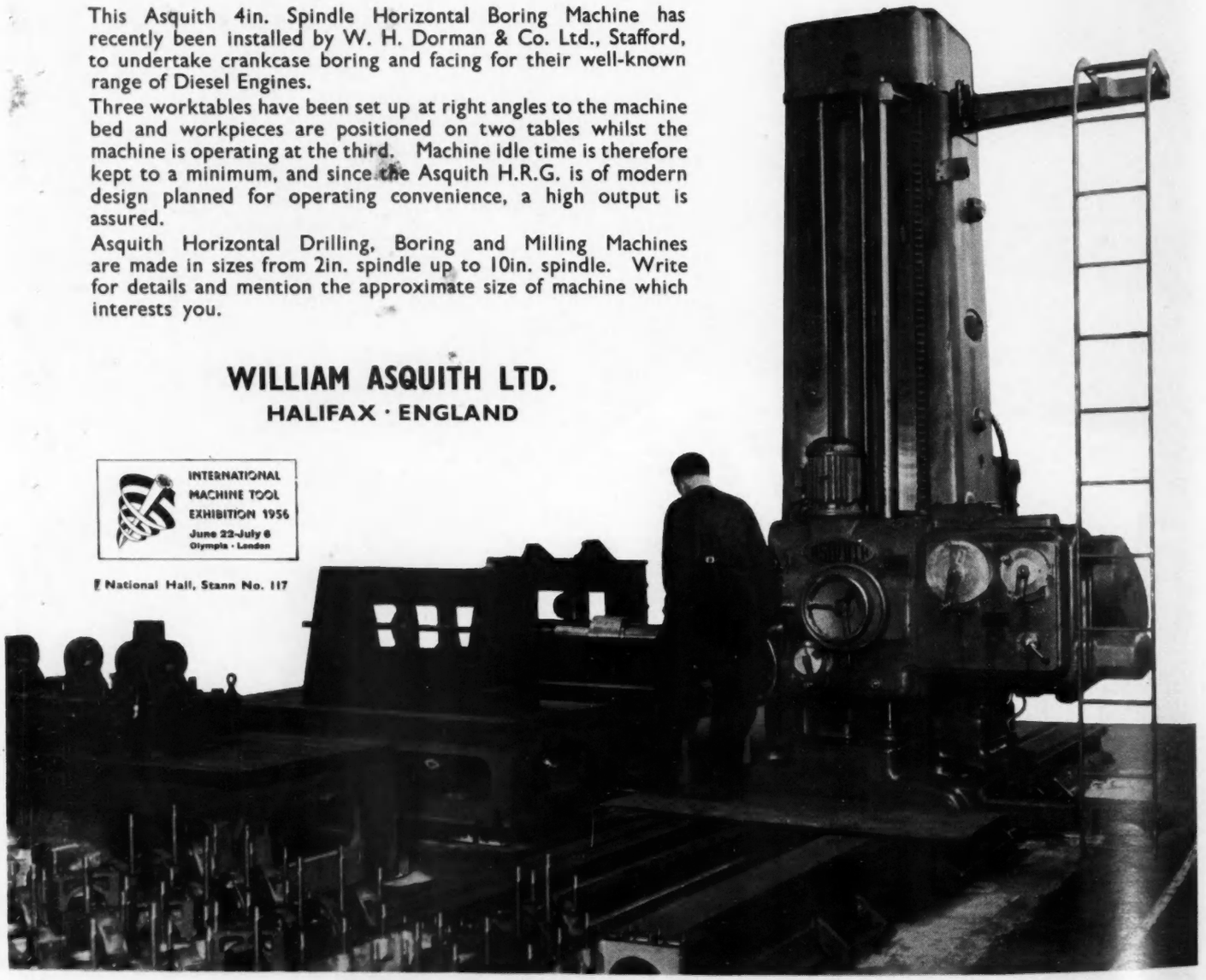

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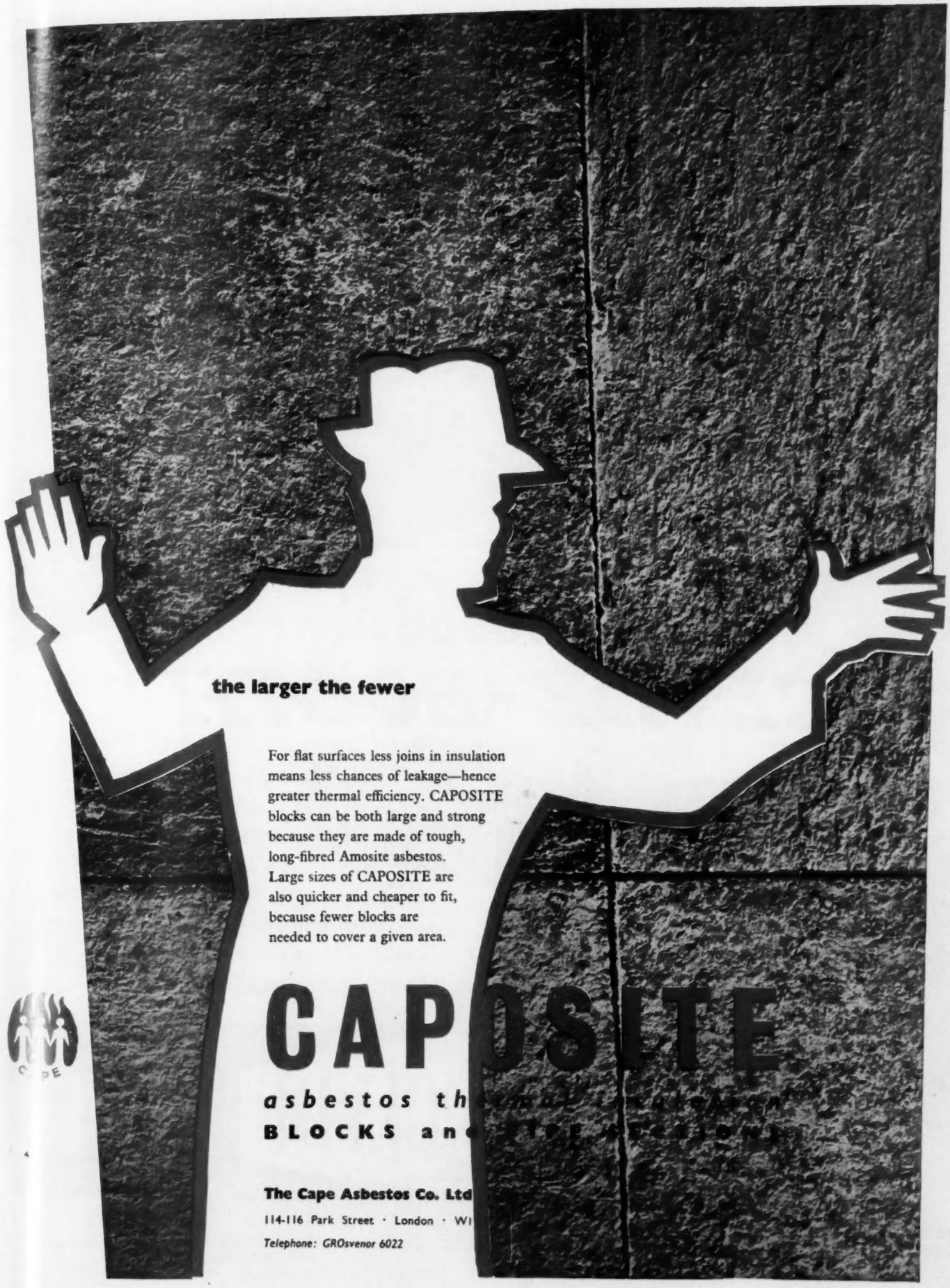
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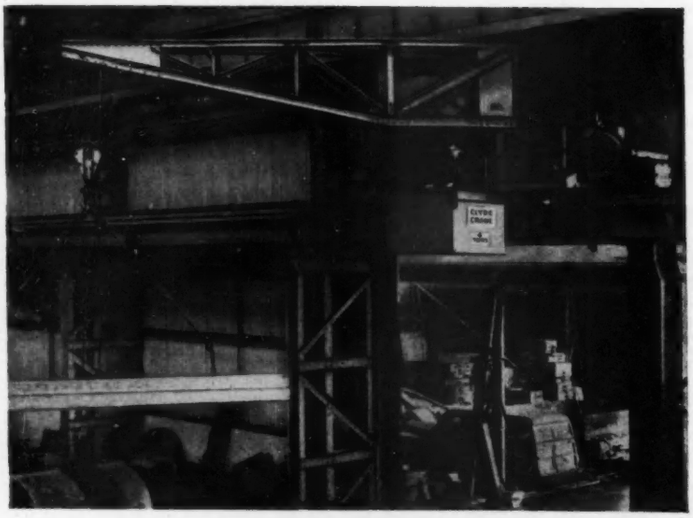

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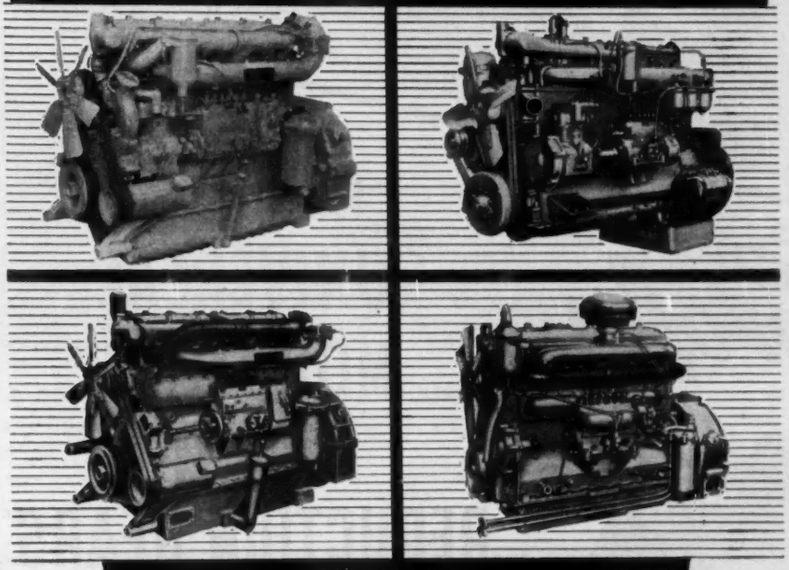

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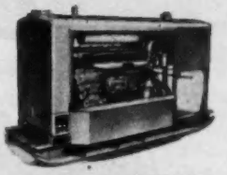

LEYLAND AUTO-DIESEL GENERATOR

BLAW-KNOX BK-12 MOTOR GRADER.

MODEL	BORE	STROKE	SWEPT VOLUME	WEIGHT (DRY)	RATINGS (BS.649—1949 AT N.T. & P.)		
					1 hour or less	12 hours or less	Day and night
350 Vertical or Horizontal	3.96 in. (100.6 mm.)	4.75 in. (120.7 mm.)	351 cu. in. (5.75 litres)	1,178 lb. (545 Kg.)	91 b.h.p. at 2,200 r.p.m	78 b.h.p. at 2,000 r.p.m.	64 b.h.p. at 1,800 r.p.m.
600 Vertical or Horizontal	4.8 in. (121.92 mm.)	5.5 in. (139.7 mm.)	597 cu. in. (9.8 litres)	1,625 lb. (738 Kg.)	125 b.h.p. at 1,800 r.p.m.	112.5 b.h.p. at 1,800 r.p.m.	92 b.h.p. at 1,600 r.p.m.
680 Vertical or Horizontal	5 in. (127 mm.)	5.75 in. (146 mm.)	677 cu. in. (11.1 litres)	1,640 lb. (744.5 Kg.)	150 b.h.p. at 2,000 r.pm.	135 b.h.p. at 2,000 r.p.m.	115 b.h.p. at 1,800 r.p.m.
900 Vertical or Horizontal	5.5 in. (139.7 mm.	6.5 (165.1 mm.)	927 cu. in. (15.2 litres)	2,580 lb. (1170.2 Kg.)	200 b.h.p. at 1,840 r.p.m.	170 b.h.p. at 1,800 r.p.m.	142 b.h.p. at 1,600 r.p.m.

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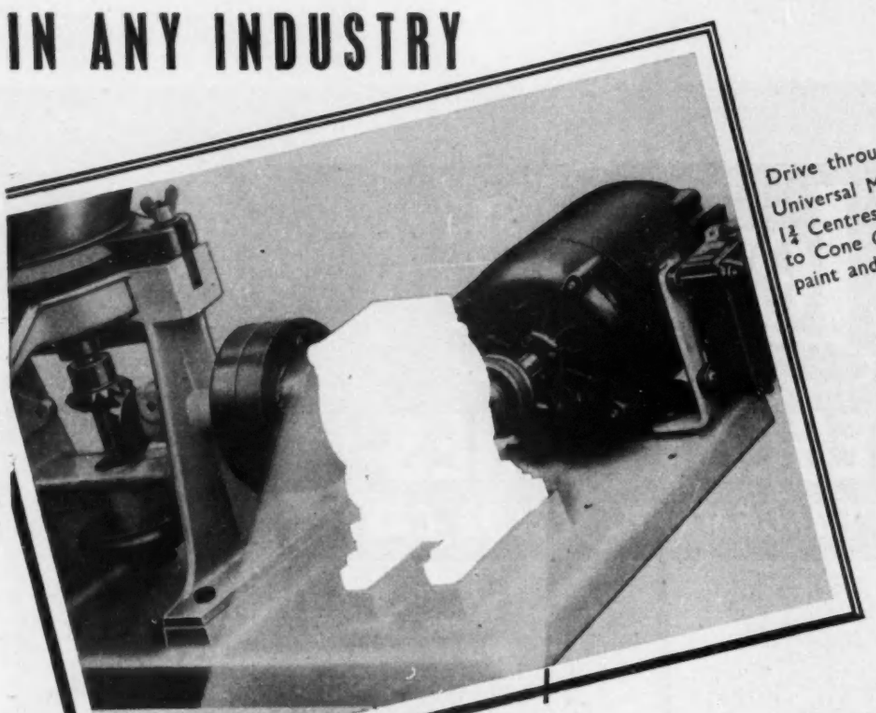

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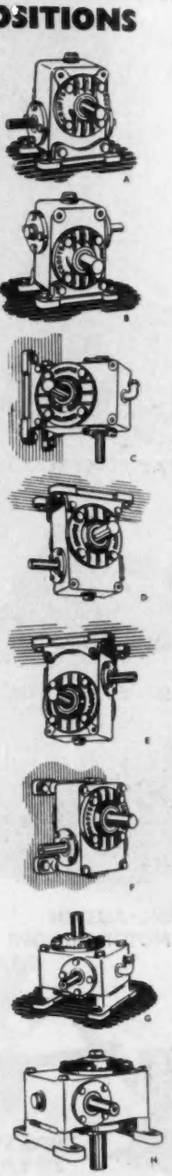

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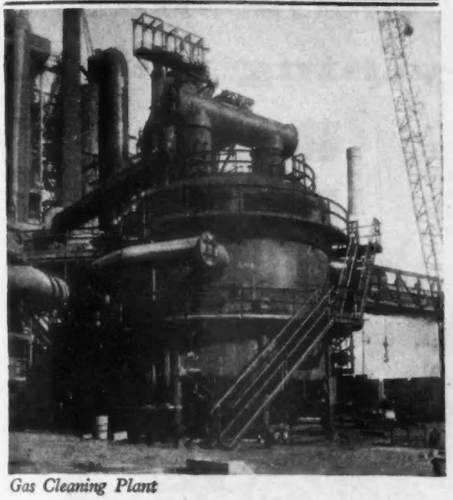

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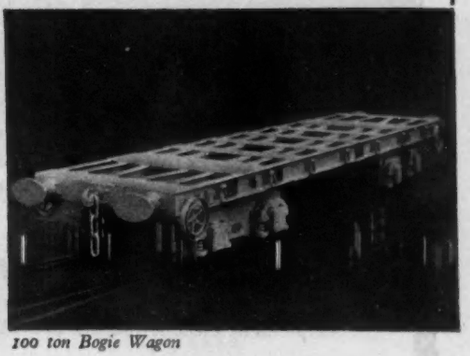

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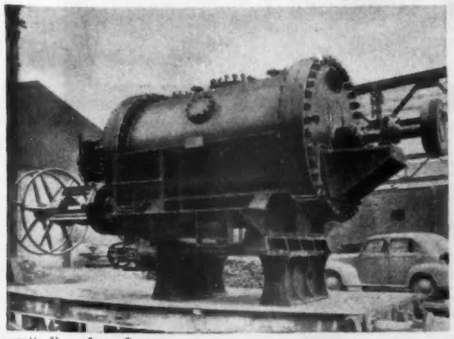

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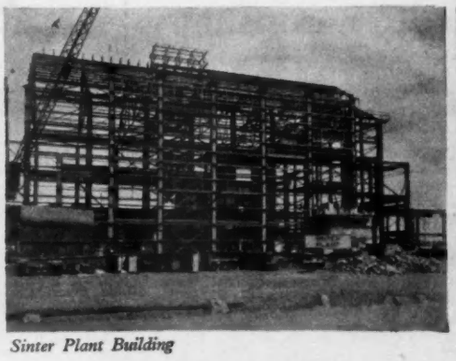

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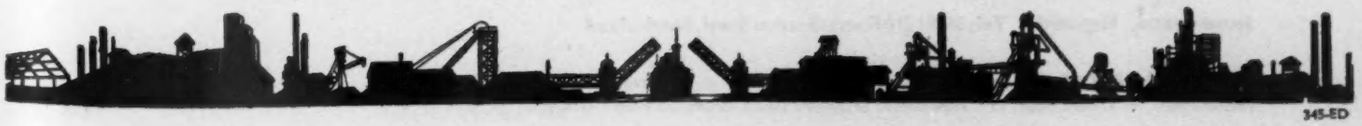

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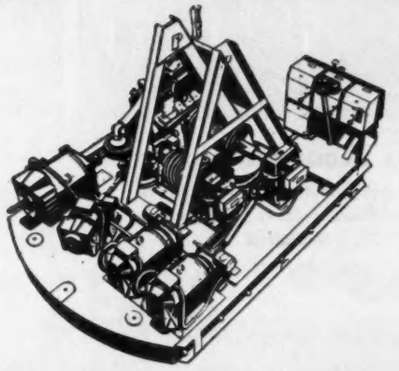

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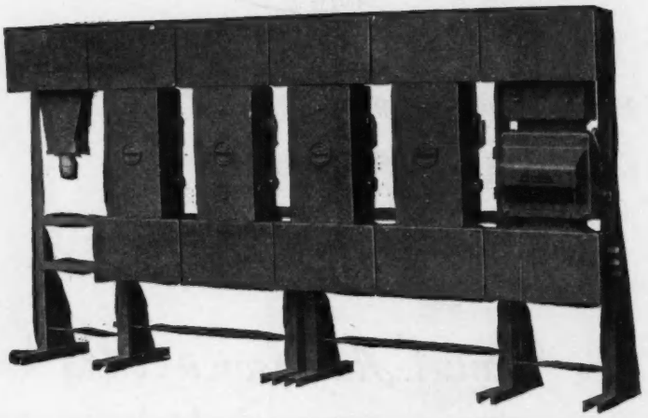

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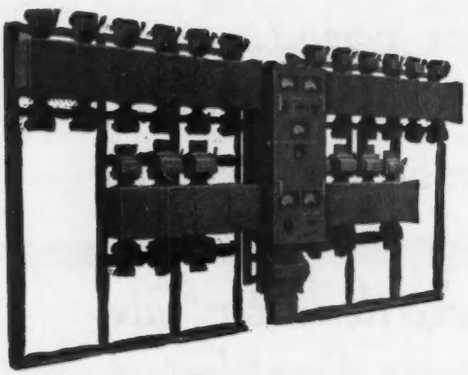
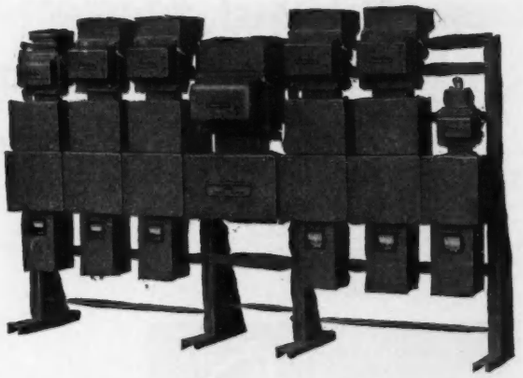


Switchboard supplied through B. French Ltd. and installed at the Carrickfergus, Co. Antrim plant of Courtaulds Ltd.



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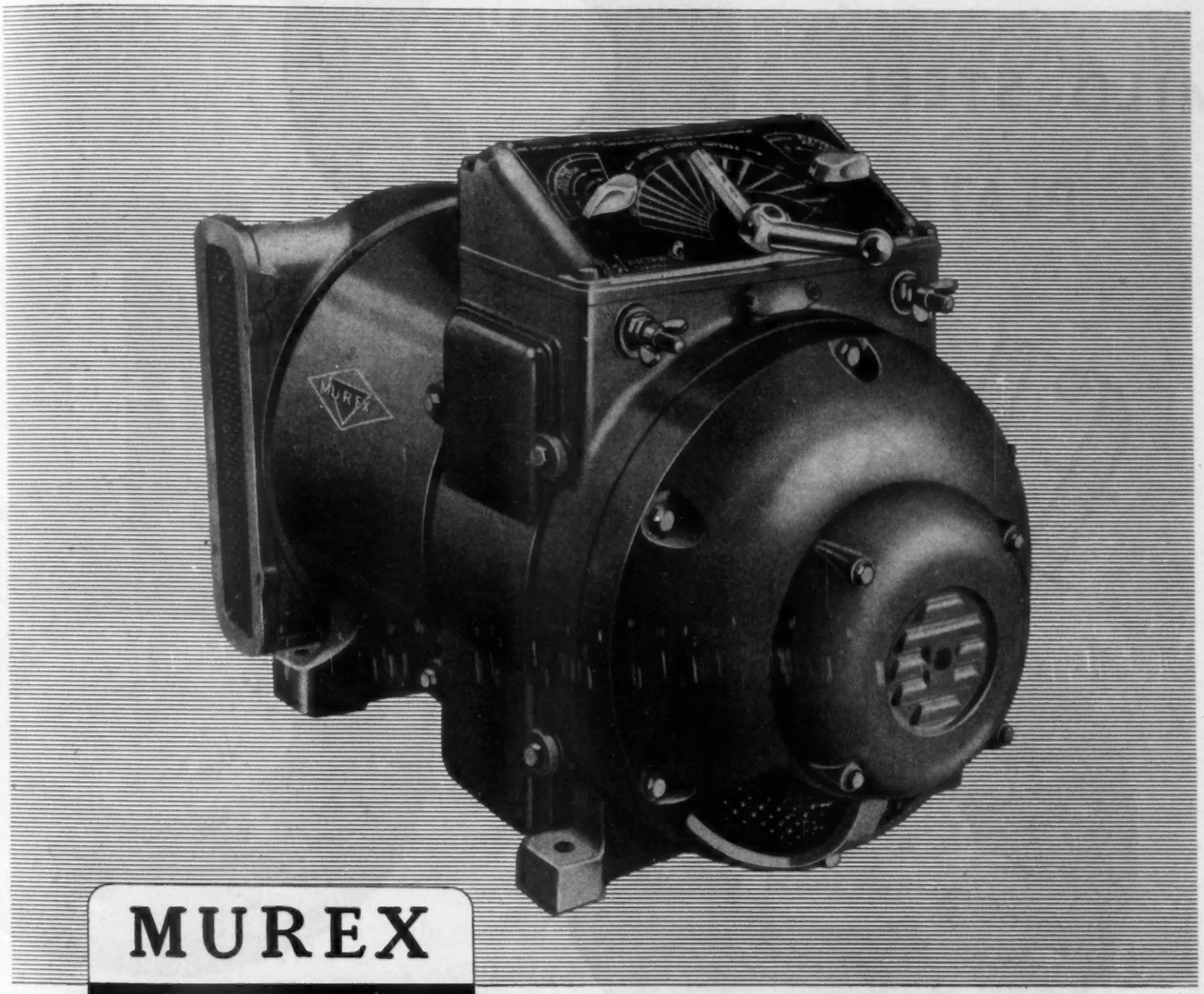

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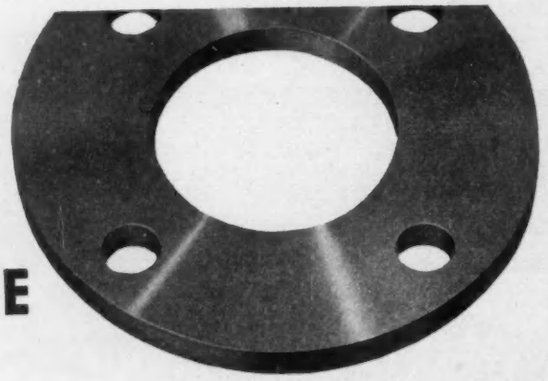
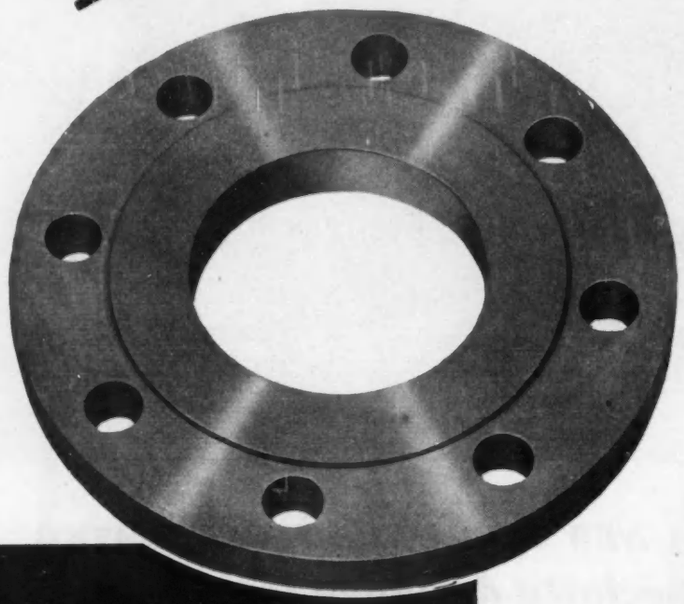
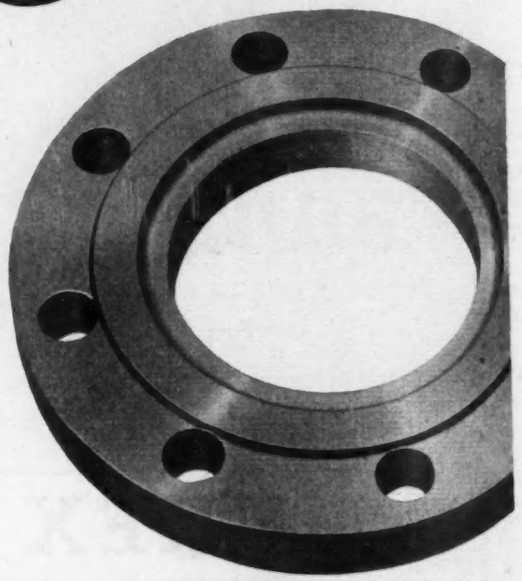
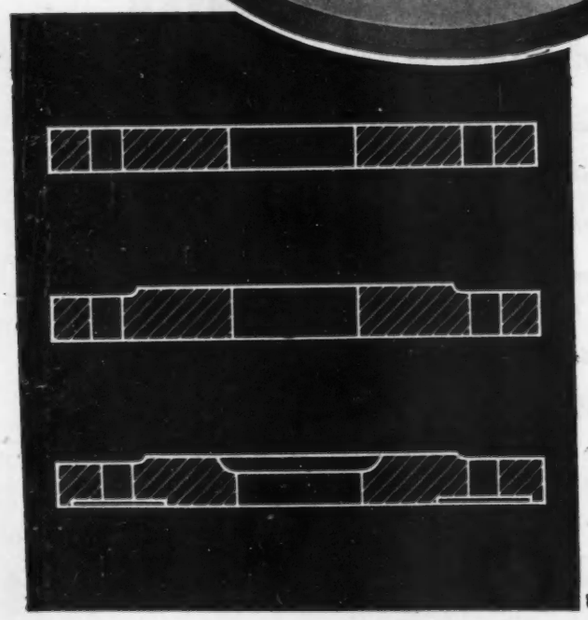


flanges







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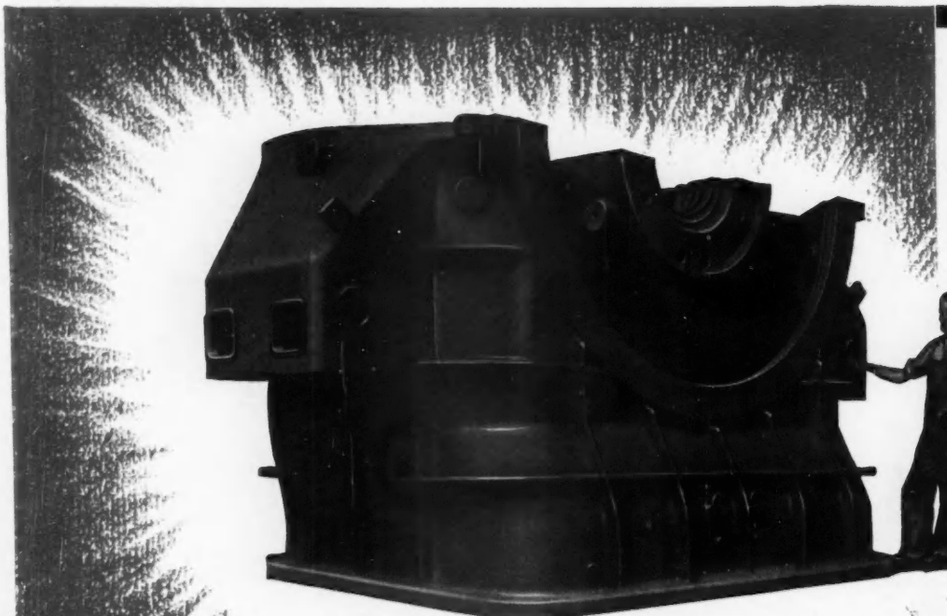

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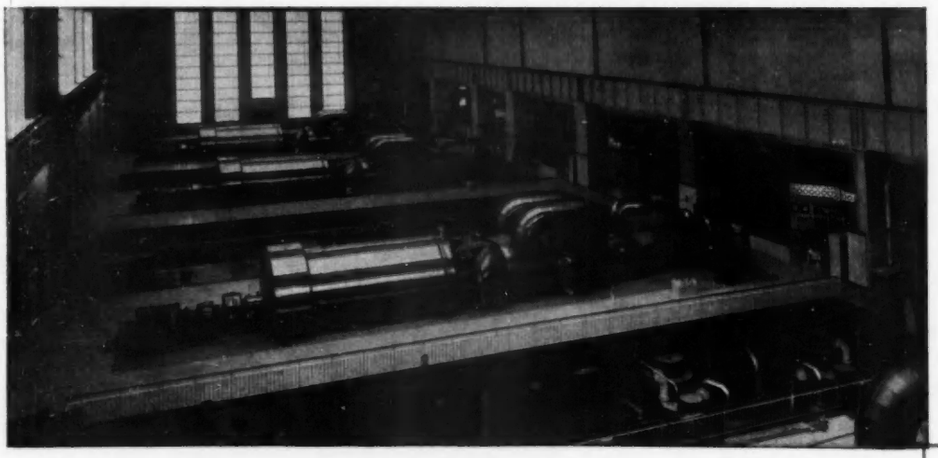

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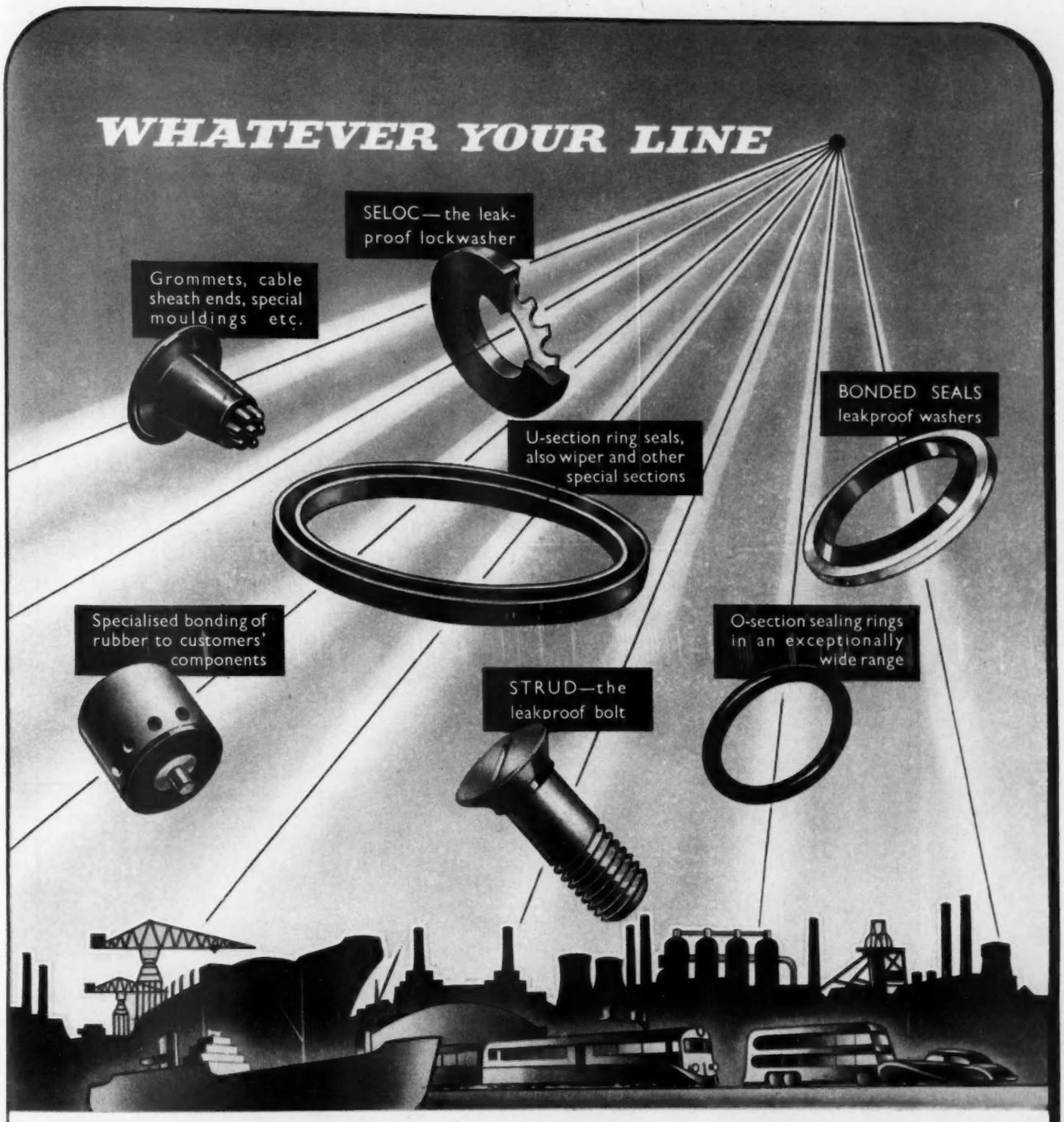
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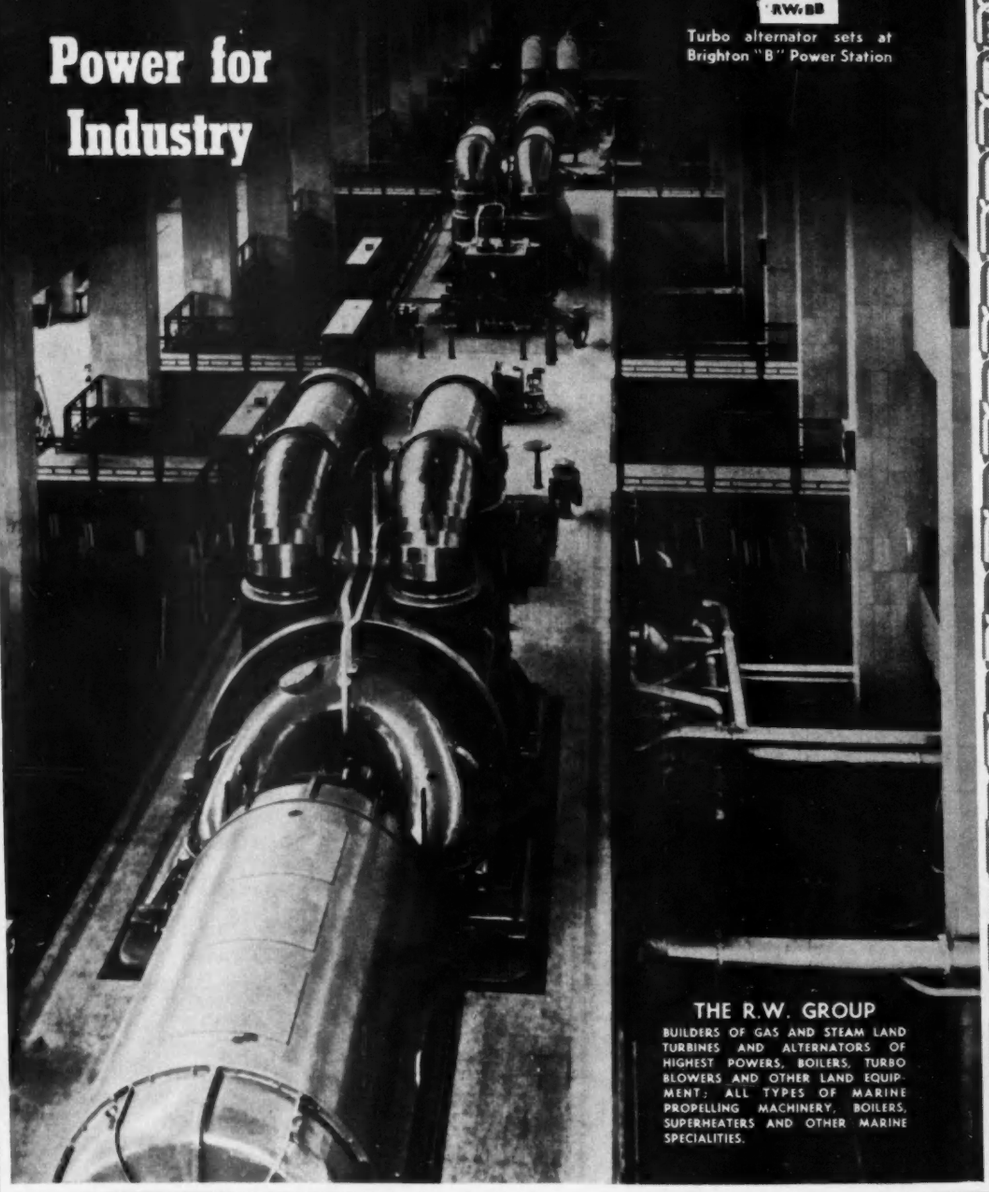

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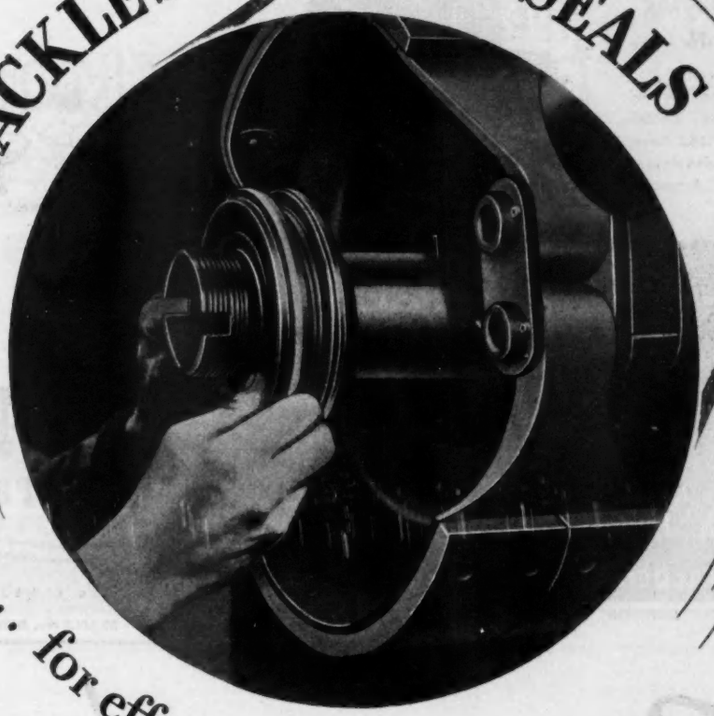

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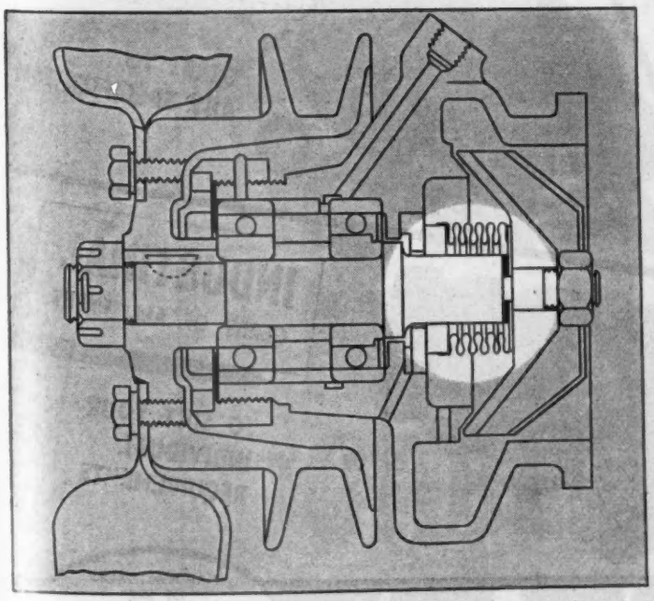

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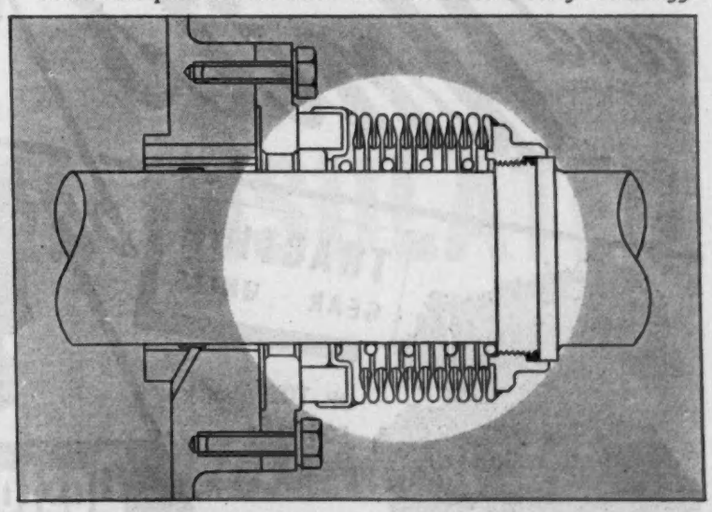

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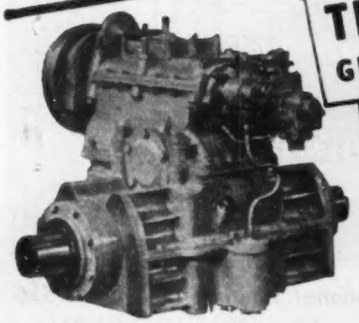

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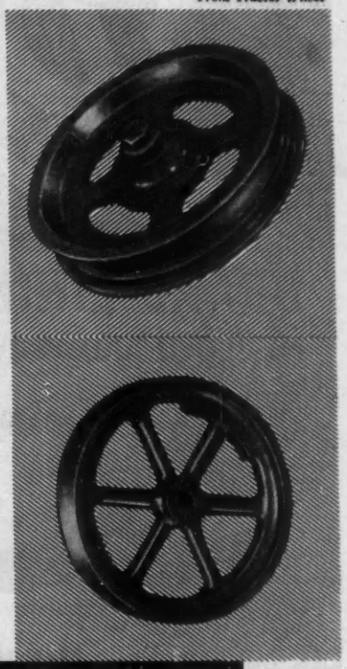

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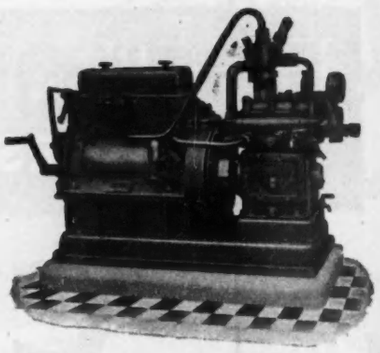
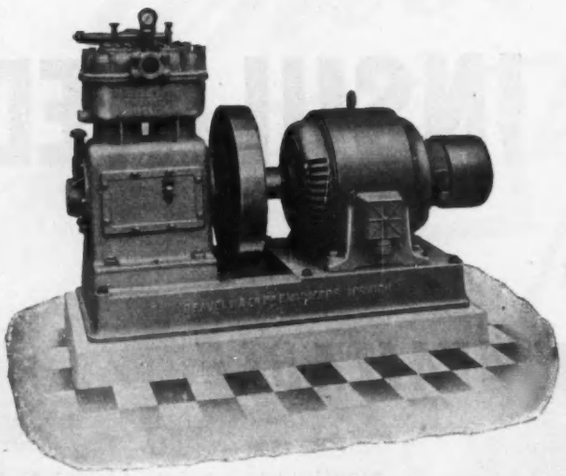
Two-stage compressors similar to that illustrated on the right are made in three types for pressures up to 450, 600 and 1000 lbs. per square inch. They are belt driven or direct coupled to electric-motors, petrol or Diesel Engines.





Single-stage compressors similar to that shown on the left are suitable for pressures up to 100 lbs. per square inch. They are made with one, two or three cylinders, according to the capacity required, and are driven in the same way as the machines above.

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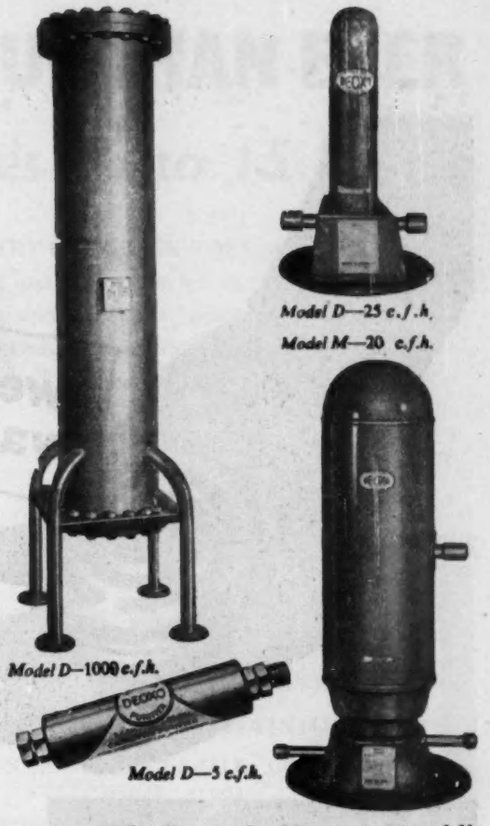

Model D—25 c.f.h.
Model M—20 c.f.h.
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★ *A copy of the illustrated publication, giving full details of the 'Deoxo' process, will be forwarded on application. Technical representatives are always available for consultation and advice.*

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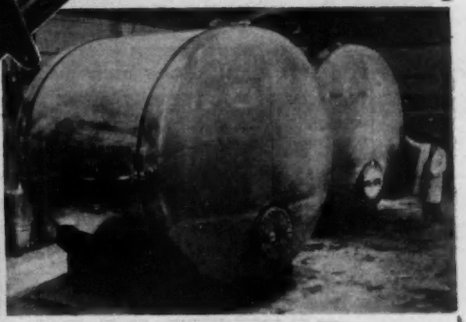

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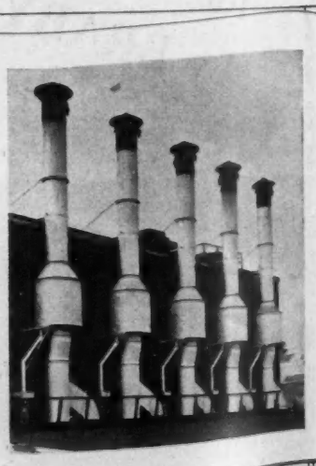

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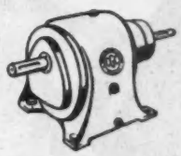

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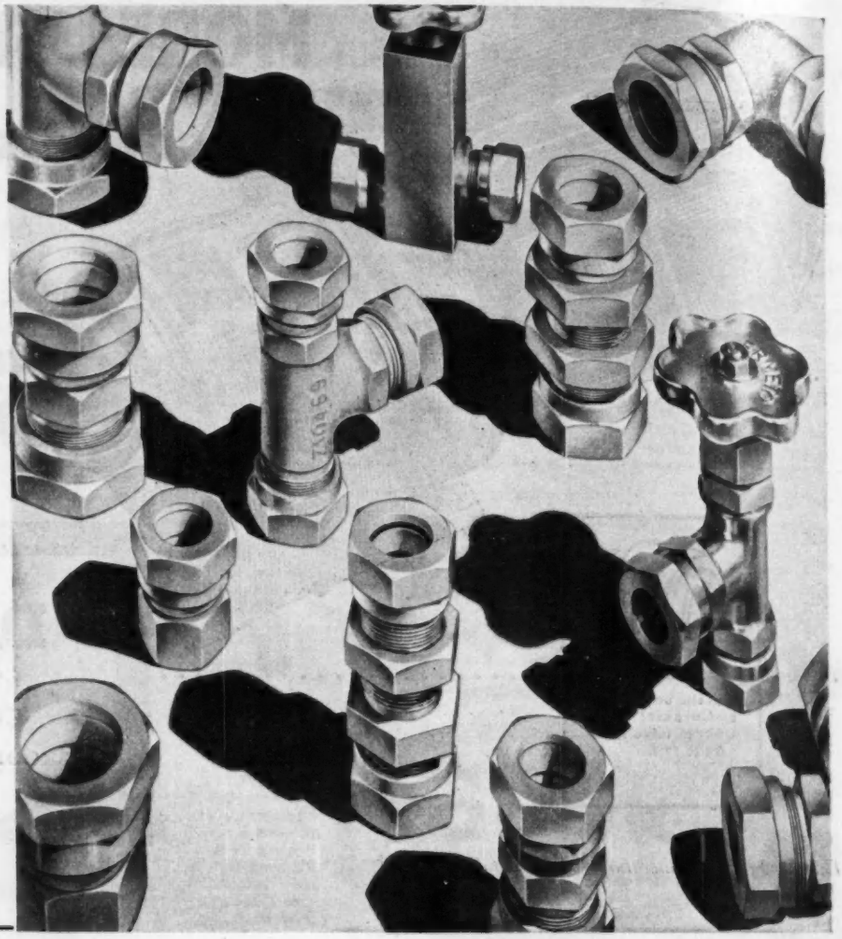

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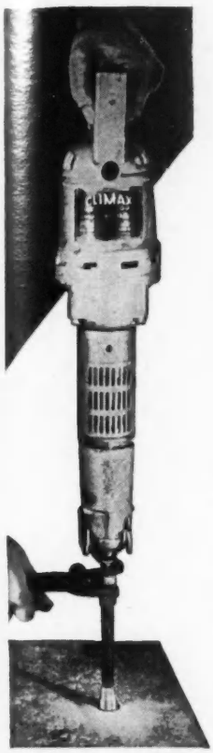

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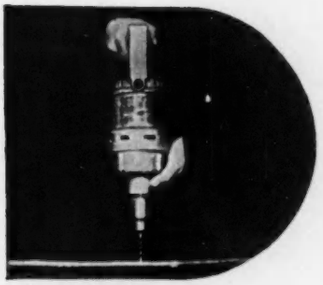
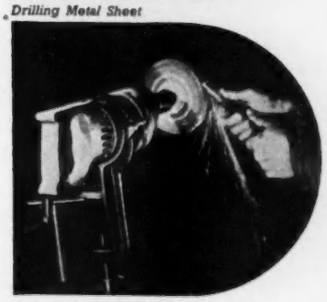


Drilling Metal Sheet



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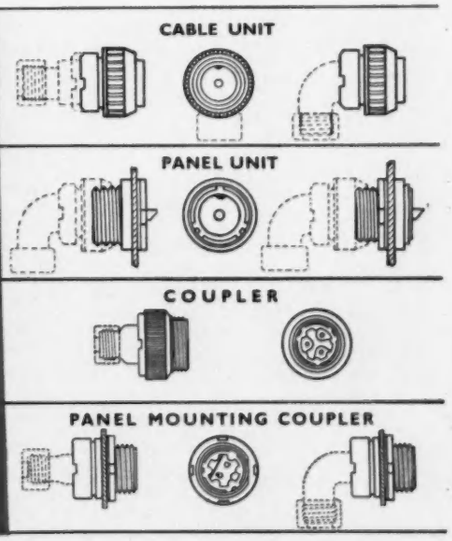

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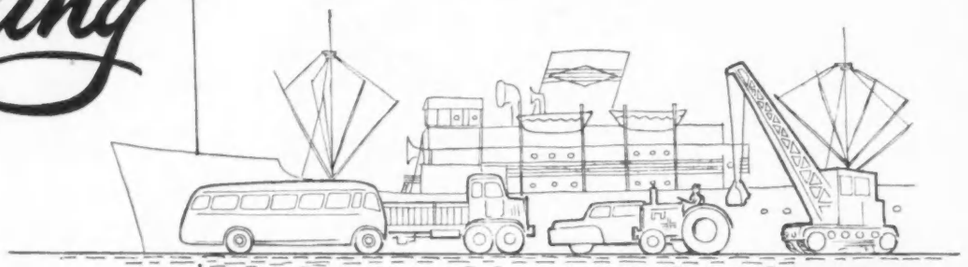

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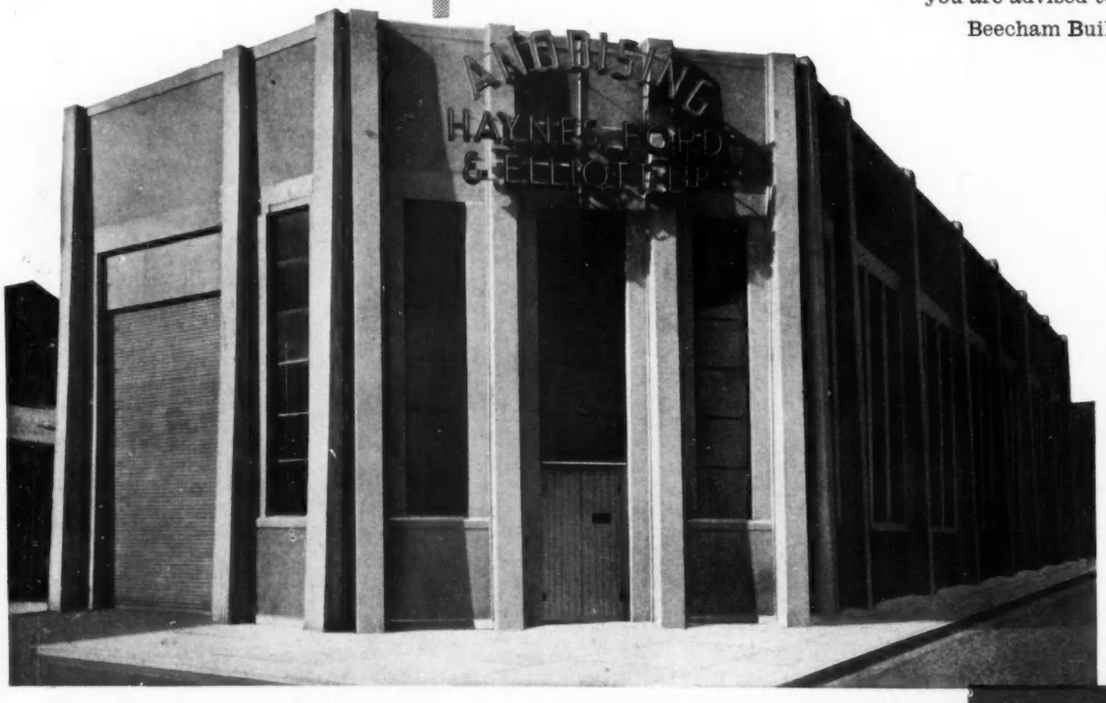

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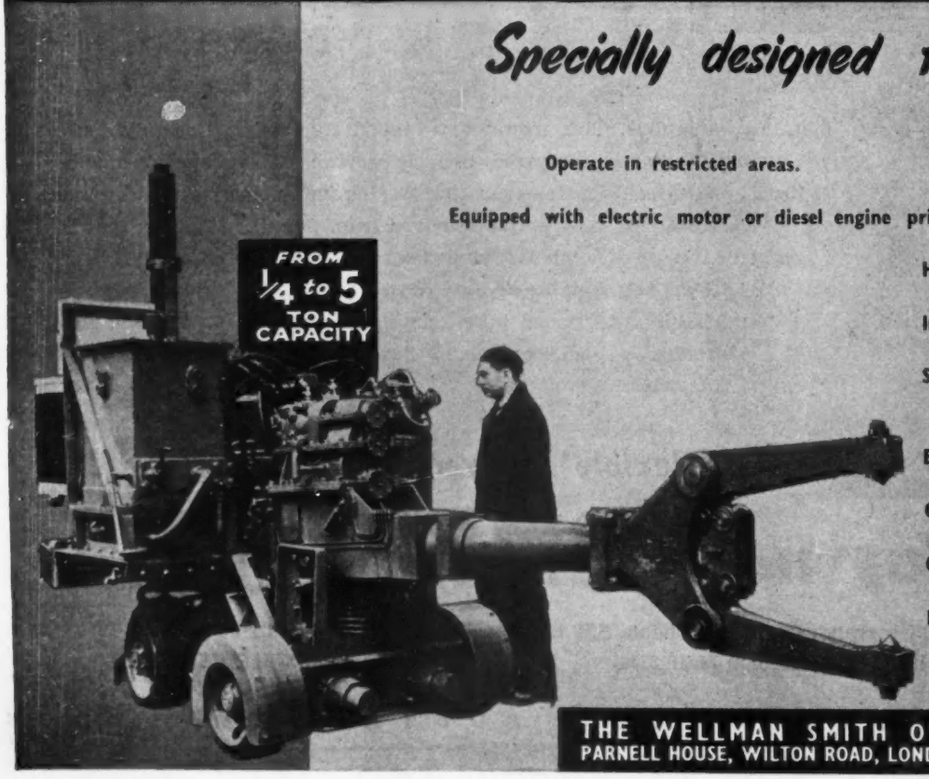

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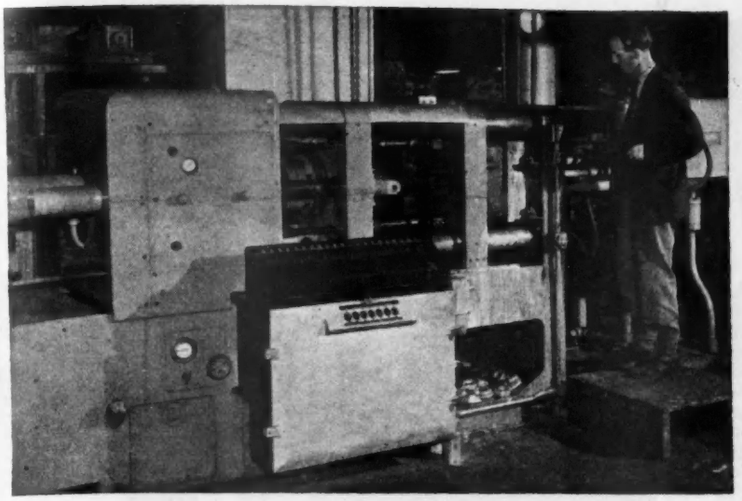

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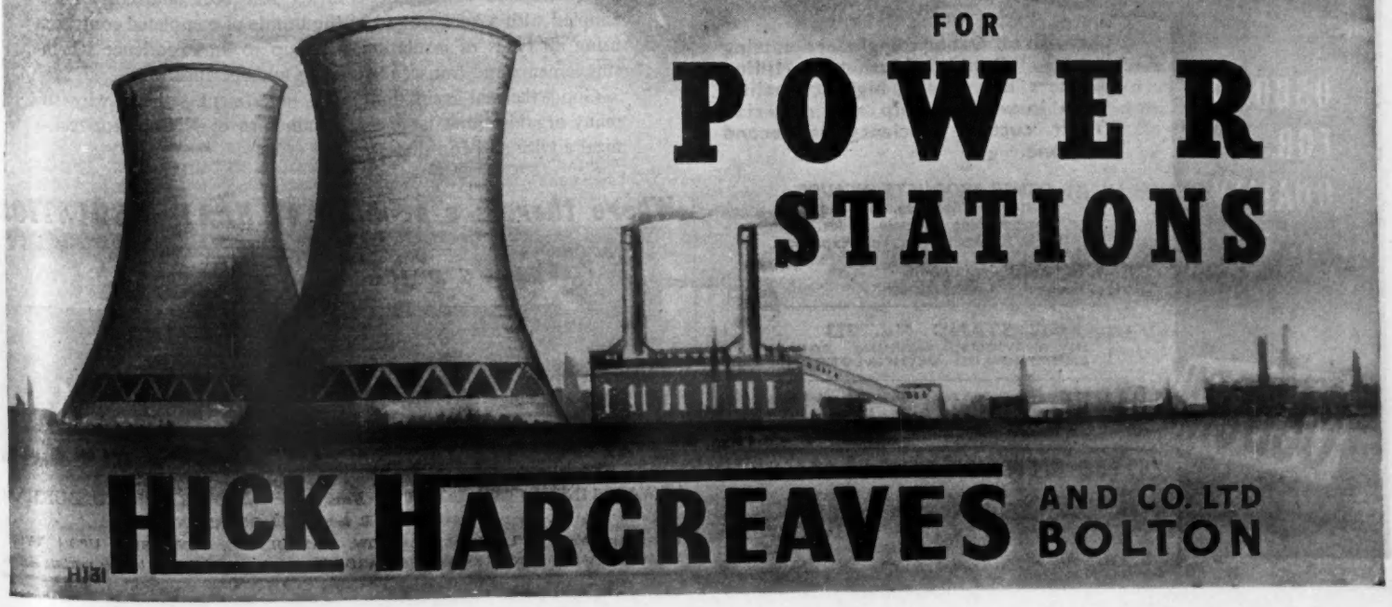

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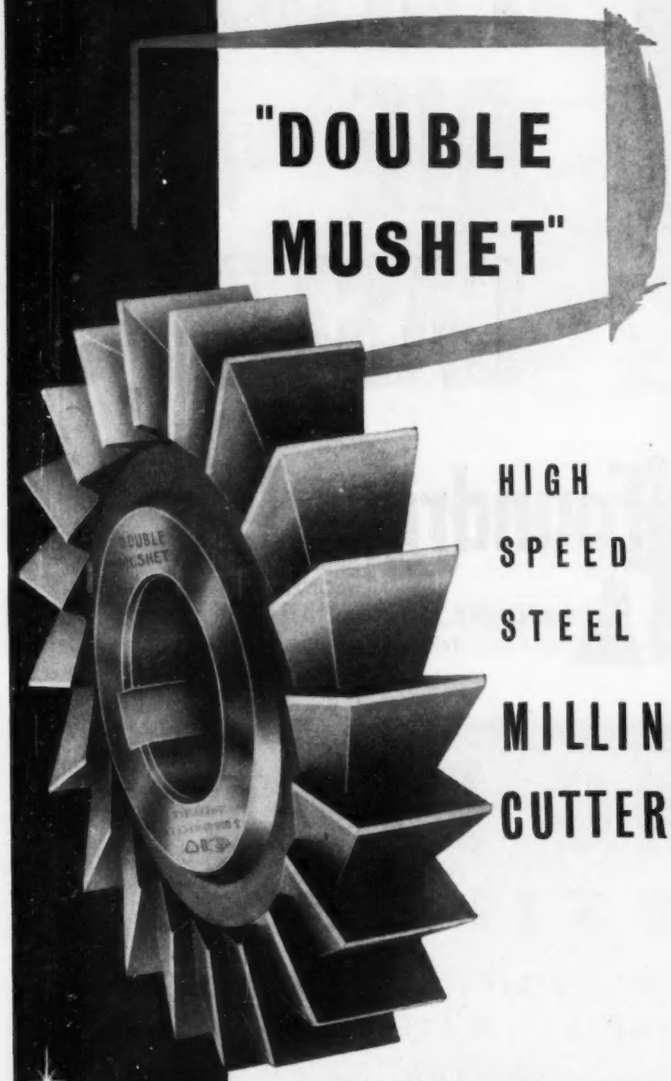

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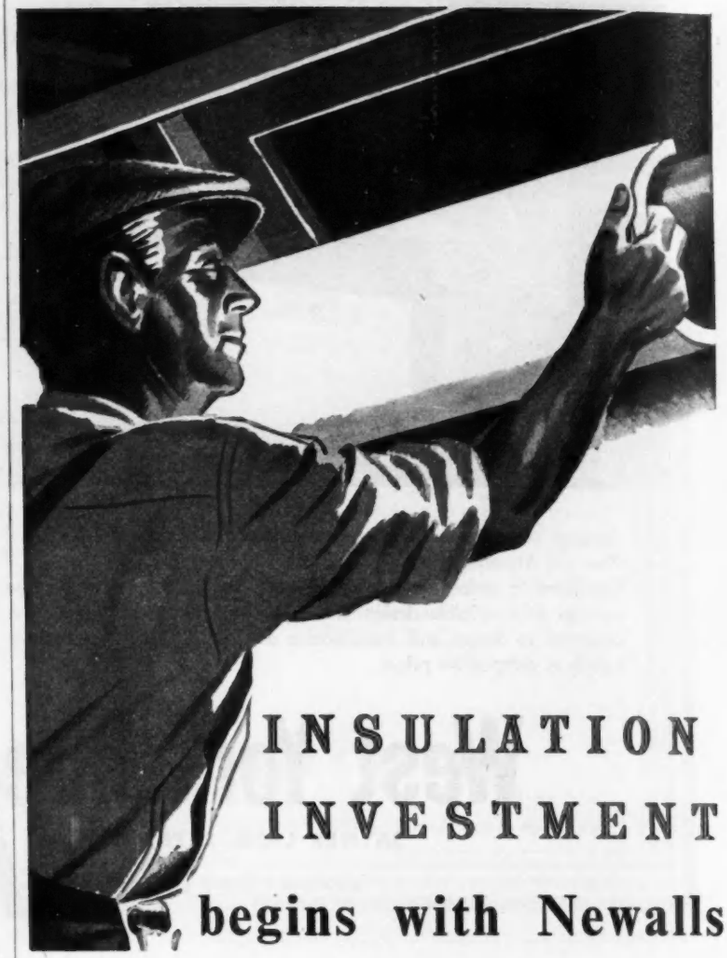

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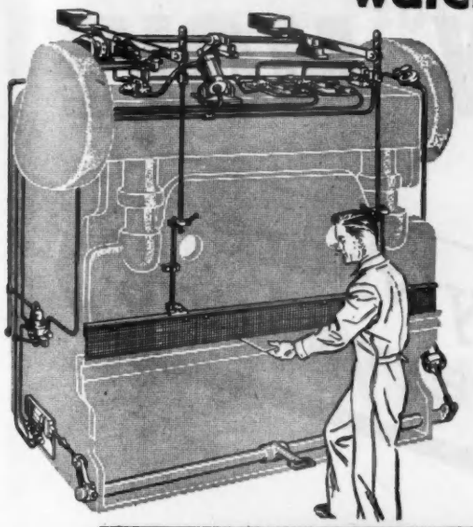

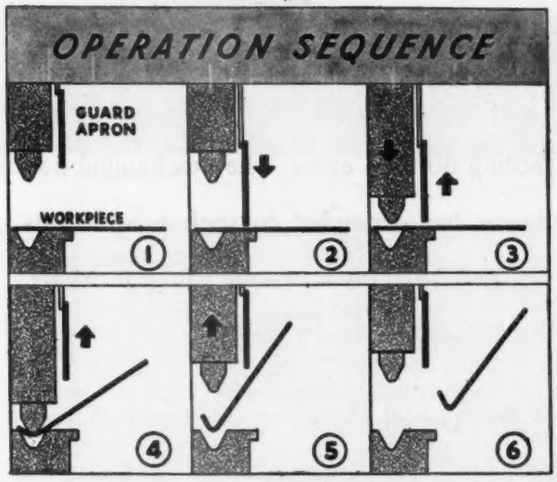

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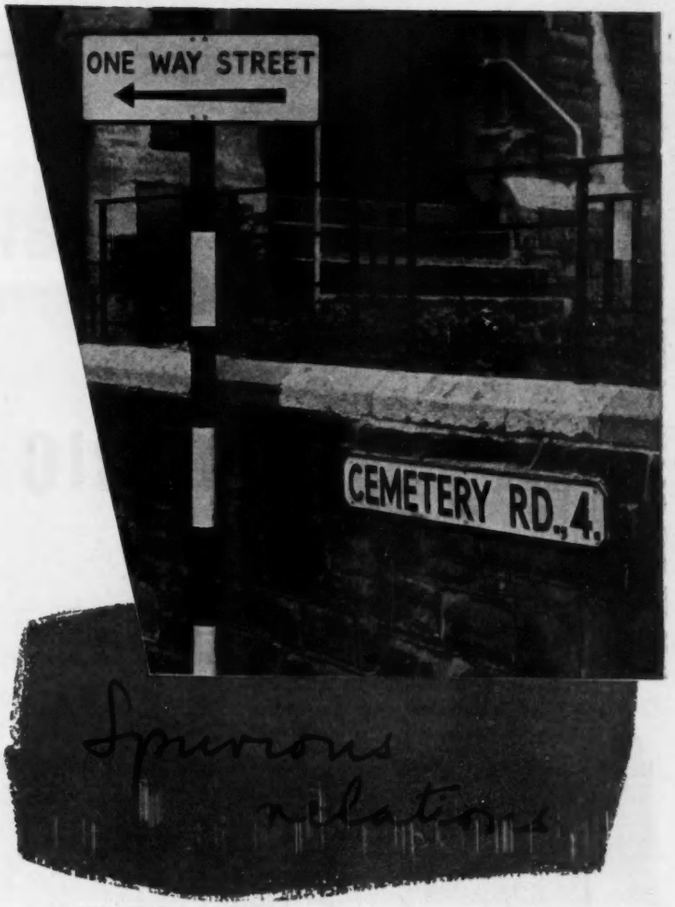

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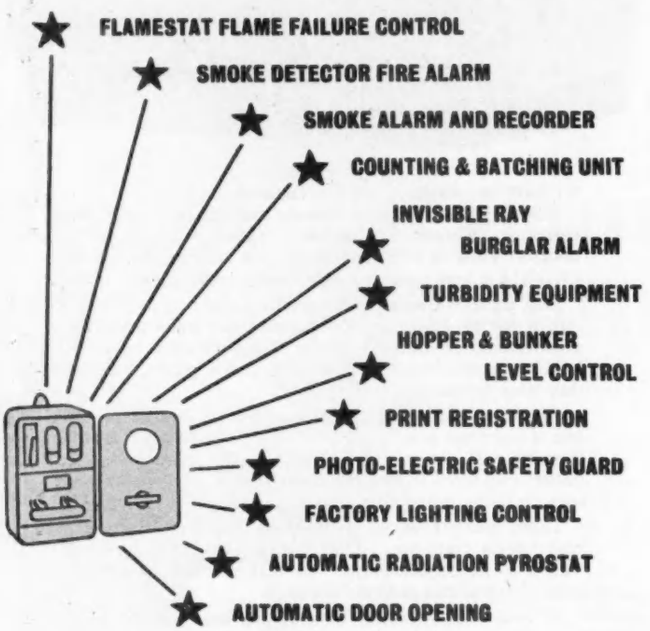

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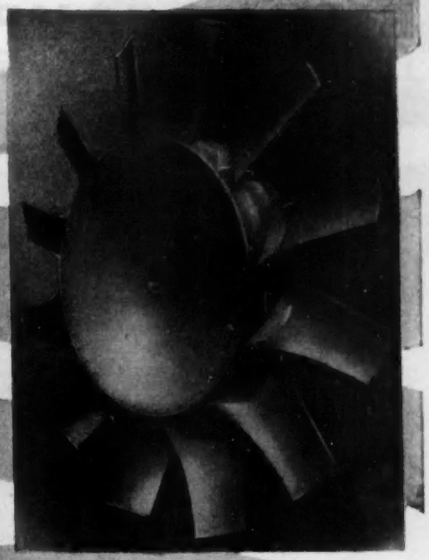

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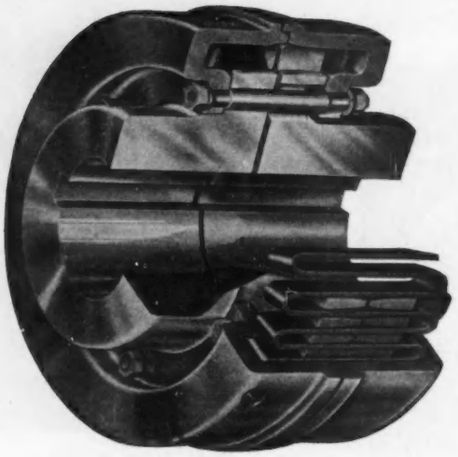

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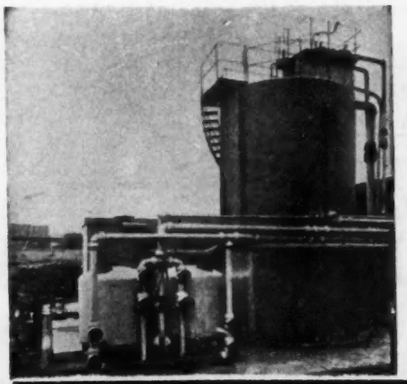

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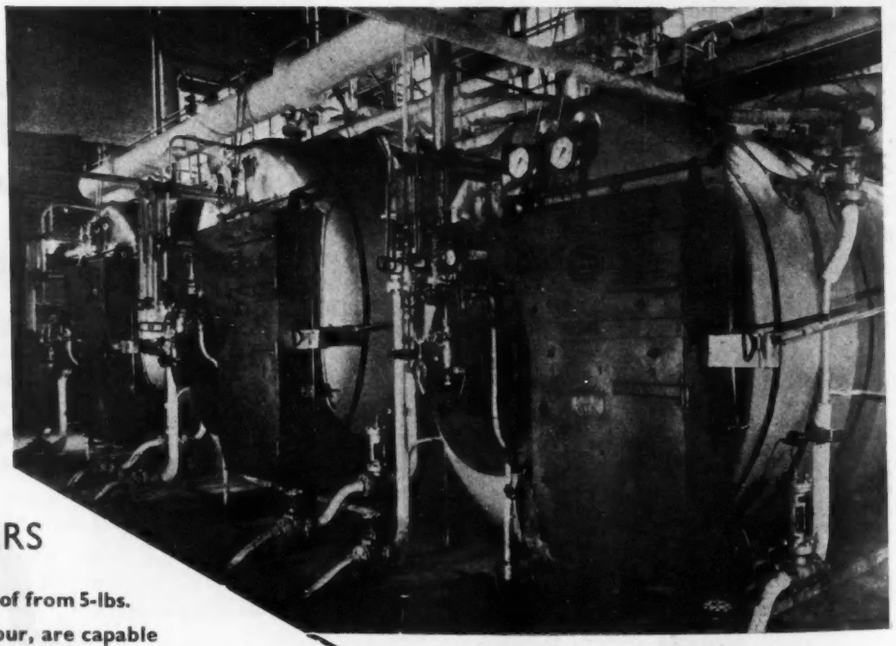

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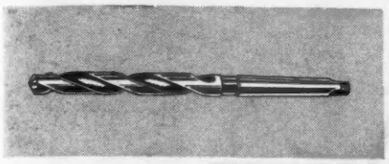
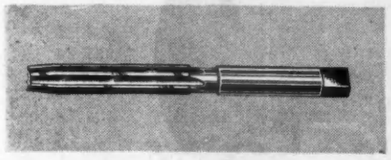
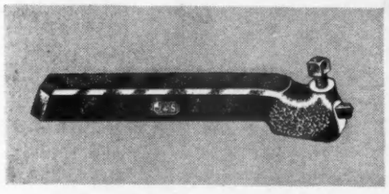
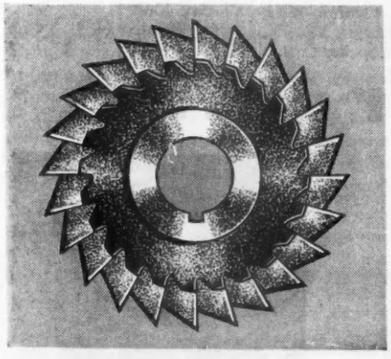
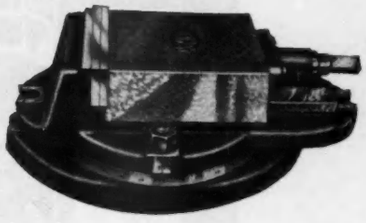
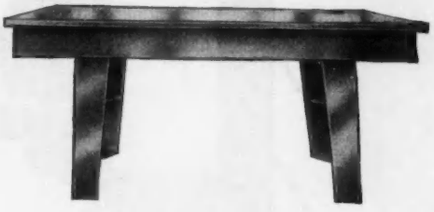
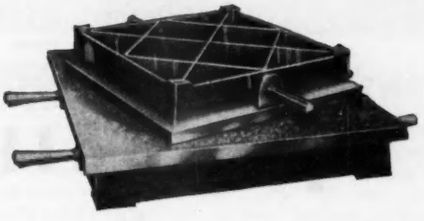

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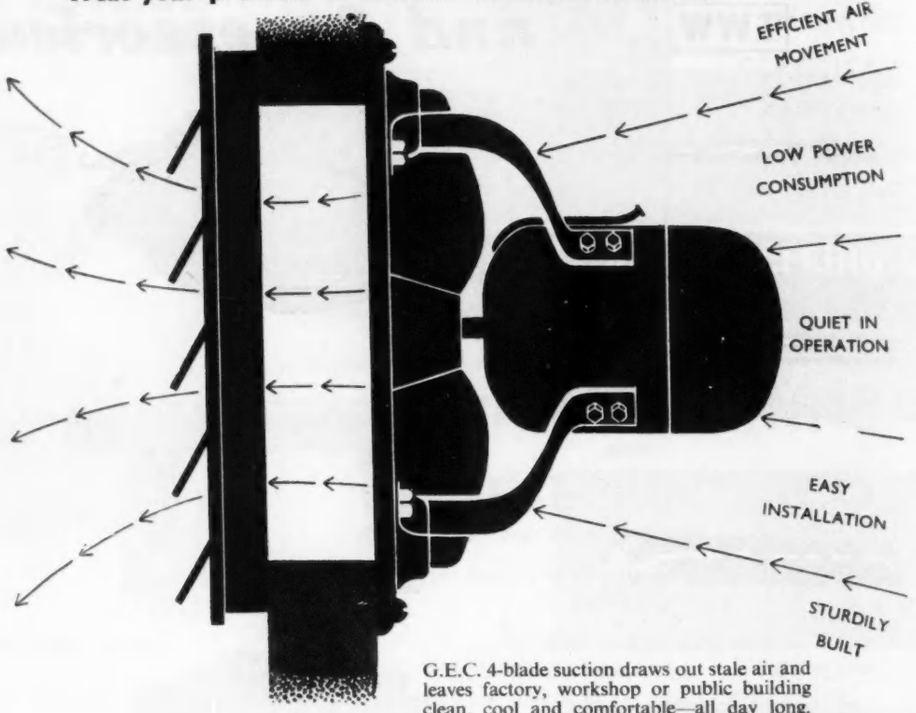

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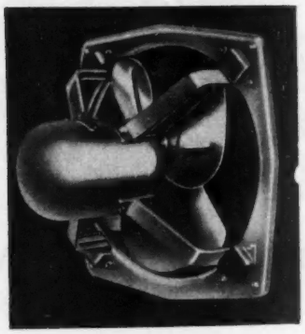

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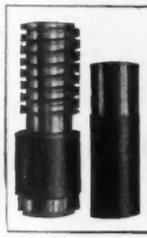

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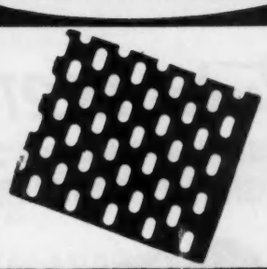

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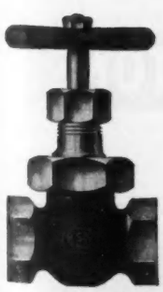

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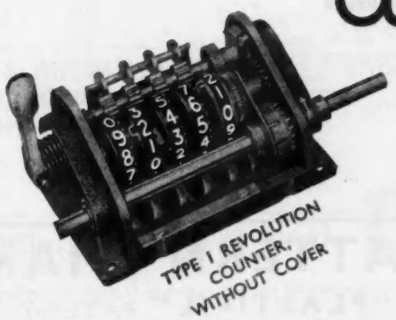

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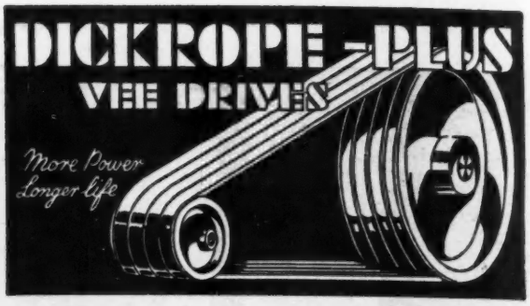

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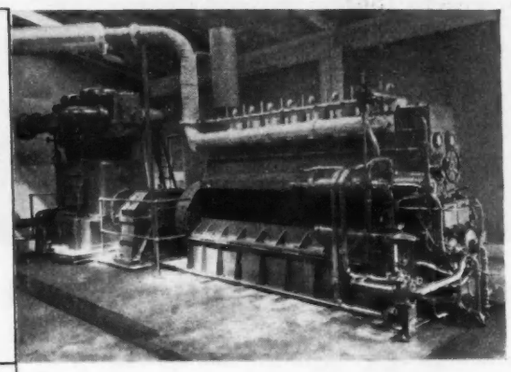

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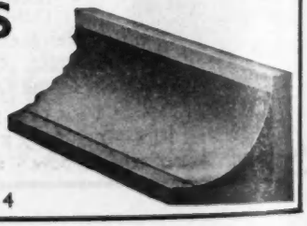

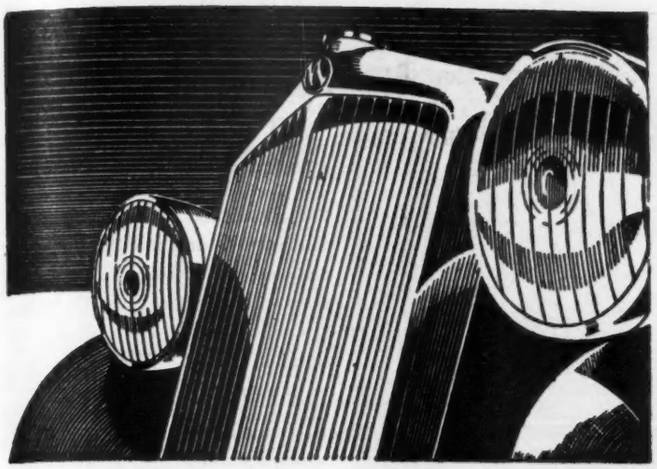

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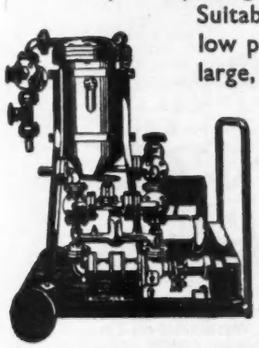

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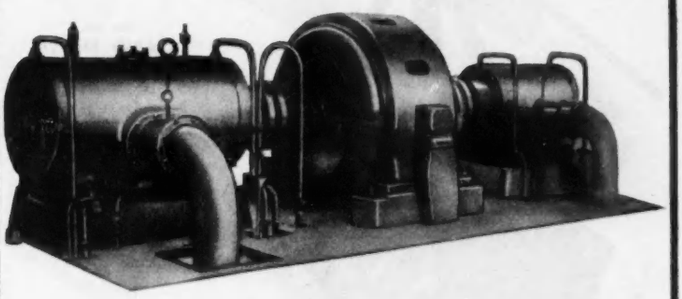

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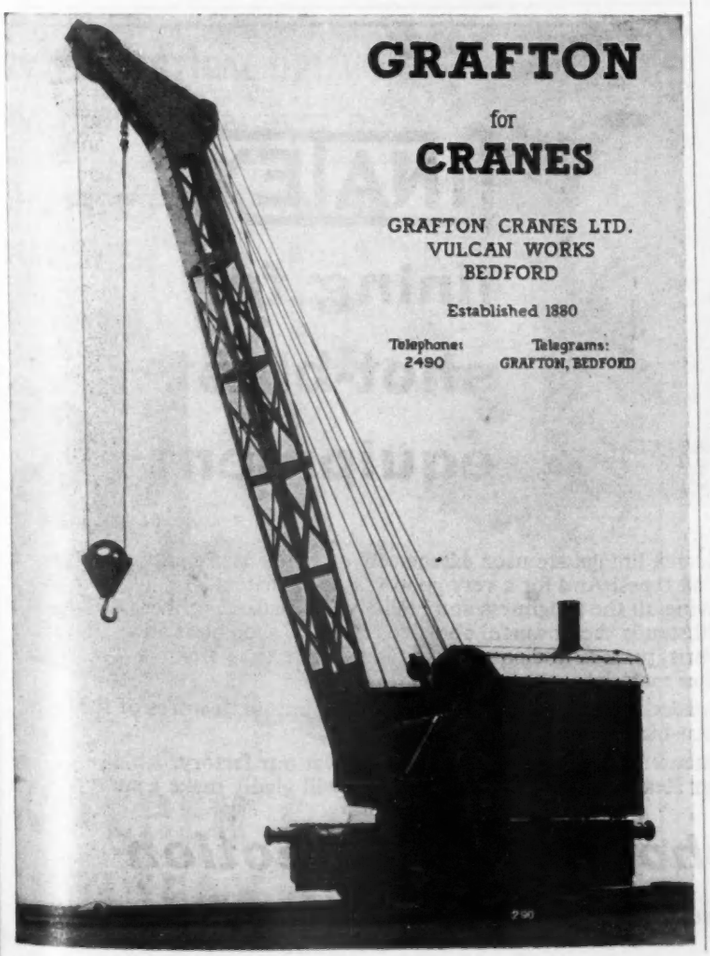

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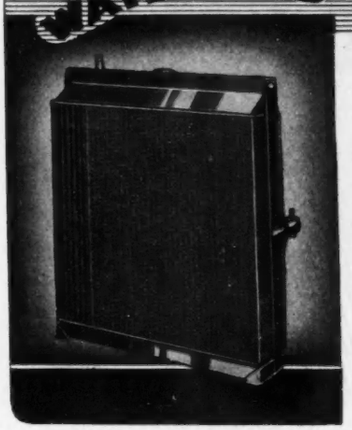

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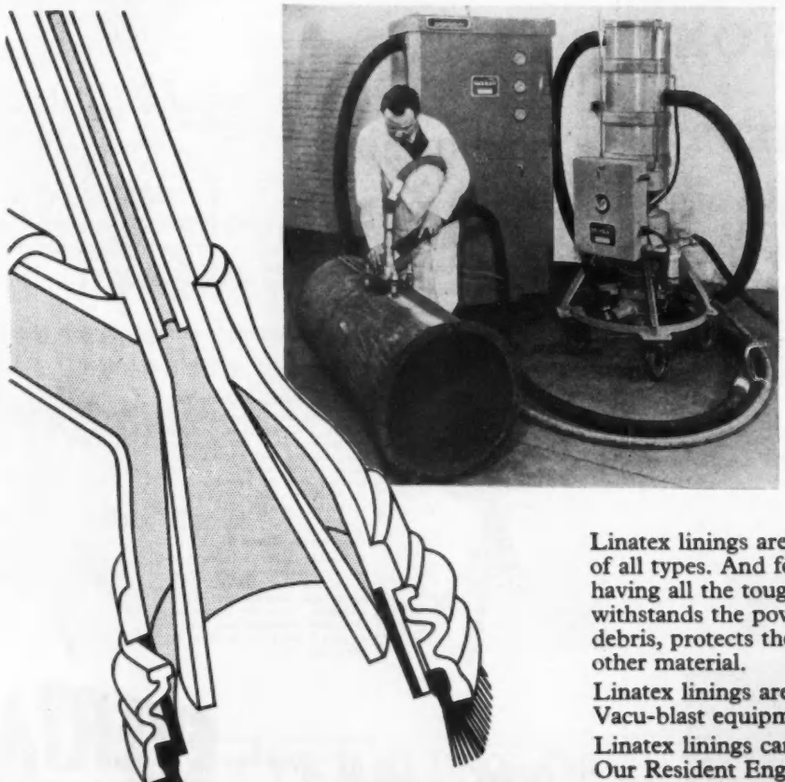

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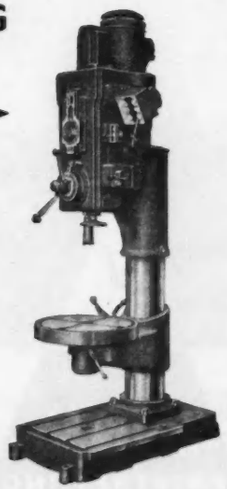

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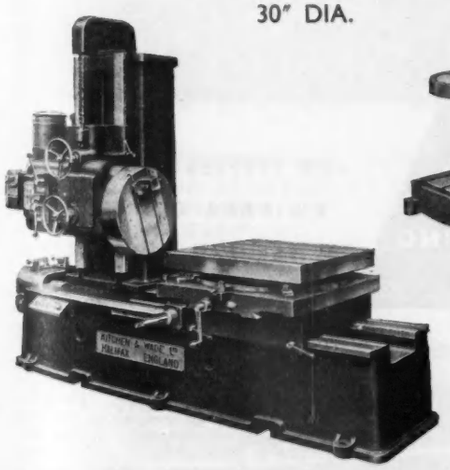

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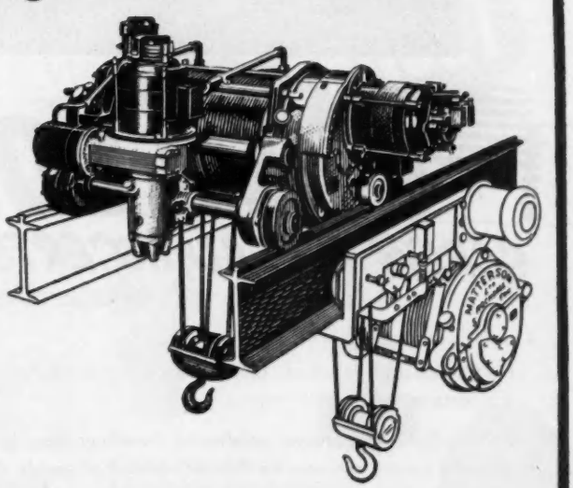

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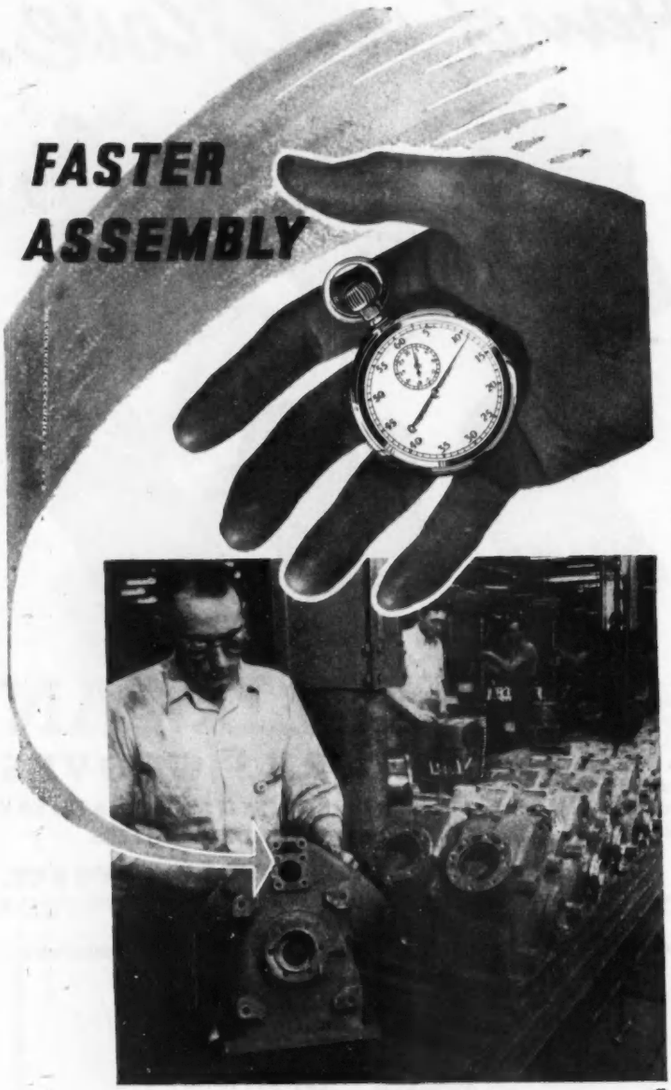

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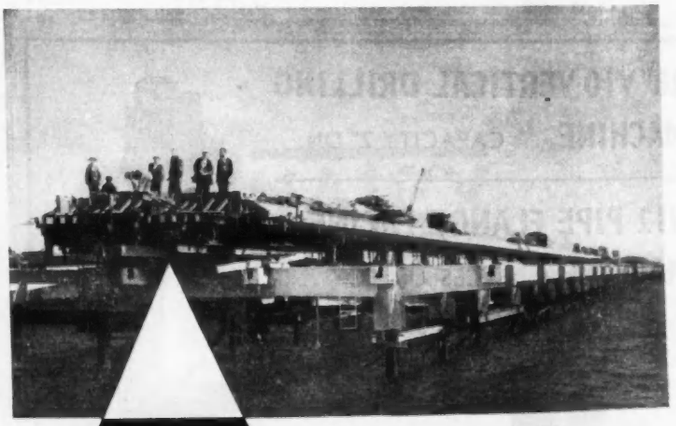

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The photograph shows the final section of the 3,000 foot main trunk way of the oil jetties at Kwinana Oil Refinery, Western Australia—which will be the largest refinery in Australia on completion. The Lee-McCall system of prestressed concrete construction was employed in the construction of these jetties.

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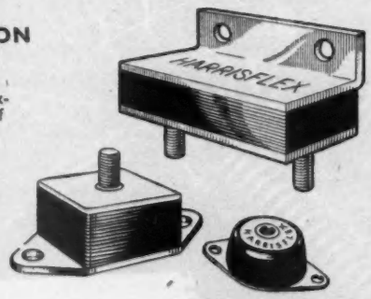

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Made solely of Nylon in various sizes. Tough, flexible and light in weight. Each clip fully adjustable throughout its range. Self-locking to facilitate rapid tightening down. Radiused inner surface prevents cable chafing.

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Stops draughts, rattles and absorbs vibration. Easy to fit, economical in use. World wide demand. Available also in "skinned" or waterproof sections. Over fifty different sizes.

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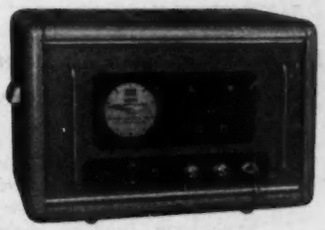
up to 5,000 counts per second

This combines into one compact unit two Dekatrons, a high speed counter, power supplies and driving stages, having a maximum count of one hundred million pulses provided by photo-electric, crystal, or electro-static pick-ups.



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It may also be controlled by external pulses from crystal oscillators or tuning forks when fitted with an "Electronic Switch".

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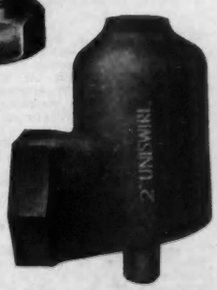
Send us details of that spray problem to-day.



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Classified Advertisements continued from Page 8

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DESIGN ENGINEER for GAS TURBINE Drawing Office, for thermo dynamic and mechanical design calculations, etc. Appli cants with degree preferable, but not essential. Candidates must be corporate members of the Institution of Mechanical Engineers, with sound technical background and some experience in Industrial Gas Turbines, Steam Turbines or Aero Engines, etc. Salary according to age and qualifications.—Application forms can be obtained from the EMPLOYMENT MANAGER, RUSTON & HORNSBY LIMITED, LINCOLN. L 31

MANAGER wanted to take complete charge of medium sized marine engineering works, Clyde area, engaged in specialised contracts. Steam engine experience essential. Some diesel and electrical experience an advantage. Knowledge of lifting machinery design also advantageous. Post offers good remuneration and excellent prospects. Only men with some managerial experience and having first-class organising ability will be considered.—Write stating age and giving full particulars of record and experience to 0441 WM. PORTEOUS AND CO., GLASGOW. L 133

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Applications are invited from qualified **MECHANICAL ENGINEERS** (preferably A.M.I.Mech.E.) for a number of permanent and pensionable appointments at Fort Dunlop. Industrial experience of plant layout and mechanical handling systems is desirable: knowledge of Work Study techniques an advantage. These positions provide excellent scope for advancement in an expanding Company with world-wide interests. Please write, giving age, qualifications, experience and salary required, to the PERSONNEL MANAGER, DUNLOP RUBBER CO., LTD., FORT DUNLOP, ERDINGTON, BIRMINGHAM, 24. L 190

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NORTHUMBERLAND. L 259

ELECTRICAL DRAUGHTSMAN required for interesting work on large Chemical Plant Installations. Applicants should have technical ability to deal with a variety of problems including power and lighting schemes. Salary commensurate with age and experience. Five-day week, Pension Fund and Luncheon Vouchers.—Applications, which will be treated in confidence, should give previous experience and qualifications and be addressed to: LAPORTE CHEMICALS LIMITED, CLIFTON HOUSE, EUSTON ROAD, LONDON, N.W.1. L 235

JIG AND TOOL DESIGNER required by DAVEY PAXMAN & CO., LTD., COLCHESTER, ESSEX. Batch production diesel engine components. Excellent working conditions; five-day week; pension scheme; sports and canteen facilities. —Apply in writing to PERSONNEL MANAGER. L 237

DESIGN DRAUGHTSMEN.

Design Draughtsmen (mechanical) required by rapidly expanding N.W. London Company with factories in provinces. Capable designers are needed to work on plant development and production operation extensions. Experience of factory layout, services and intricate mechanisms an advantage. Technical qualifications to H.N.C.; O.N.C. considered but dependent on experience. Salary £800 p.a. upwards according to ability. Excellent prospects, pension and life assurance scheme. Five-day week.—Full details in strict confidence to BOX L 238, Offices of ENGINEERING.

BRITISH PETROLEUM COMPANY LIMITED invites applications from
YOUNG GRADUATES with a degree in Engineering, Physics, Mathematics or Natural Philosophy to be trained as Petroleum Engineers. Training will last for approximately two years and will take place partly in the United Kingdom and partly overseas. On successful completion of the training, men will be posted as Resident Petroleum Engineers to exploration areas overseas. Age preferably not over 26, National Service obligations must have been fulfilled.—Write stating age and full details of qualifications and experience quoting H.2089 to BOX 8816, c/o 191, GRESHAM HOUSE, E.C.2. L 236

METHODS ENGINEERS.

A modern organisation in the Light Electrical Engineering field in S.W. Lancs. has several vacancies for experienced methods engineers for the development and improvement of production and manufacturing methods, or for tool and special machine design for large-scale production of high precision small parts and assemblies in light electrical and mechanical engineering.

Applicants should have a sound engineering training and some experience in this type of work. Good prospects for men of progressive outlook and able to take responsibility for development and introduction of new methods and processes.

Please write to BOX L 239, Offices of ENGINEERING, giving full details of age, experience and qualifications and approximate salary sought.

EXPERIENCED PLANNING ENGINEERS required for production methods on medium I.C. engine components and fuel injection equipment. Pleasant working conditions, generous salary. Attractive Pension Scheme and Comprehensive Welfare Facilities.

Apply CHIEF PERSONNEL OFFICER, PETTERS LIMITED, CAUSEWAY WORKS, STAINES, MIDDLESEX. L 242

SENIOR JIG AND TOOL DRAUGHTSMEN required for Tool Design on
(*a*) Small I.C. engine components.
(*b*) Fuel Injection and Hydraulic Control Mechanisms on a production basis.

Applicants should have experience in these or similar fields. Pleasant working conditions, generous salary commensurate with qualifications demanded. Attractive pension scheme. Comprehensive welfare facilities.

Apply to CHIEF PERSONNEL OFFICER, BRYCE BERGER WORKS, STAINES, MIDDX. L 243

STRUCTURAL STEEL DESIGN ASSISTANT, with some general reinforced concrete experience required by Westminster consulting engineers. Age range 28-40. Varied work includes bridges, caissons and special structures. Salary not quoted as this will be based on experience. Post is permanent.—Particulars please to BOX L 310, Offices of ENGINEERING.

DRAUGHTSMEN. Applications are invited from experienced Mechanical Engineering and Design Draughtsmen to be the nucleus of a newly-formed Central Engineering and Planning Department to deal with expansion projects and new development work for the whole of the Pilkington Group of Companies at home and overseas.

Minimum starting salaries for Draughtsmen of H.N.C. standard range between £715 at age 25, to £840 at age 35, plus agreement and staff bonuses for which they become eligible after one year's service. Conditions include contributory Superannuation Fund, assisted house purchase and family education schemes.

Reply, stating age, qualifications and experience, to the GROUP CHIEF ENGINEER, PILKINGTON BROTHERS LIMITED, St. HELENS, LANCASHIRE. L 328

MECHANICAL
OR
CHEMICAL ENGINEER.

SCOTTISH AGRICULTURAL INDUSTRIES LIMITED require a Mechanical or Chemical Engineer, between the ages of 27 and 40, to fill a vacancy in their Fertiliser Works staff. Experience in the installation and maintenance of chemical engineering plant an advantage. Minimum qualifications required are Secondary School education and Higher National Certificate but preference will be given to candidates with an Engineering Degree, A.M.I.Mech.E. or A.M.I.Chem.E. The post is permanent and superannuated. Salary according to age, qualifications and experience.—Application forms will be forwarded to suitable candidates on receipt of brief details covering age, qualifications and experience to THE PERSONNEL OFFICER, SCOTTISH AGRICULTURAL INDUSTRIES LIMITED, 39, PALMERSTON PLACE, EDINBURGH, 12. L 269

RADIOVISOR PARENT LIMITED, Manufacturers of Photo-Electric and Electronic Control Equipment, have the following vacancy for their new factory shortly to be opened at High Path, Merton, S.W.19.

TECHNICAL CORRESPONDENT.

Previous experience in dealing with Correspondence, Press Releases and Operation Manuals essential. Good salary and excellent prospects. Canteen, five-day week and Pension Scheme.

Apply: MR. MOUNTAIN, 1, STANHOPE STREET, LONDON, N.W.1. EUSton 5905. L 260

FOREMEN. Large Engineering Company in South Midlands has vacancies in its Automatic Machine Shop for Foremen. A sound technical and practical engineering background and extensive knowledge of Mills, Drills, and Grinding essential, and some experience of Single and Multi-Spindle Automatics desirable. Must have had experience in responsible supervisory position. Excellent salary for men of proved ability.—Write in strictest confidence, giving full details of experience and present salary to BOX L 267, Offices of ENGINEERING

SENIOR ENGINEER for site in Gold Coast required by French firm, five to ten years past experience with earthwork and highway construction contractor, £2000 to £2500 p.a. Accommodation free.—CONSTRUCTIONS COIGNET TOGO, 11 MYRON HERRICK, PARIS, FRANCE. L 268

A FLIGHT TEST

Group has the following staff vacancies:—

(A) A MAN WITH SOME MATHEMATICAL QUALIFICATIONS, and an interest in pre-flight assessment and trials analysis for autostabiliser work.

(B) A MAN WITH INSTRUMENT EXPERIENCE for outside servicing and installation.

Some knowledge of servo systems would be an advantage for both posts. Pension scheme.—Please apply in writing giving full particulars to: PERSONNEL OFFICER, LOUIS NEWMARK LTD., PREFECT WORKS, PURLEY WAY, CROYDON, SURREY. (Lodge Hill 2131, Extension 21.) L 257

ASSISTANT MECHANICAL ENGINEER required by London consulting engineers. Previous experience on design side of dockside equipment, graving dock plant and accessories helpful. Extensive experience not essential but some drawing board work is required to enable co-ordination with civil engineering side. Age range about 30 to 35. Salary will be related to qualifications and experience.—Please reply to BOX L 253, Offices of ENGINEERING.

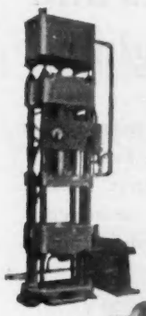
ENGINEERS for development work on cables, overhead transmission systems and railway electrification schemes. The work covers a wide diversity of electrical and mechanical problems and involves the undertaking of specific projects under the general guidance of a senior development engineer. Previous experience in the electrical supply industry or traction engineering would be an advantage but is not essential. Candidates should be qualified to graduate standard or equivalent.—Applications should be submitted to the STAFF OFFICER, BRITISH INSULATED CALLENDER'S CABLES, LTD., PRESCOT, LANCS, quoting reference P/23/56. L 300

Classified Advertisements continued on Page **116**

Visit the FAWCETT FINNEY LIMITED

STAND AT B·I·F

CASTLE BROMWICH



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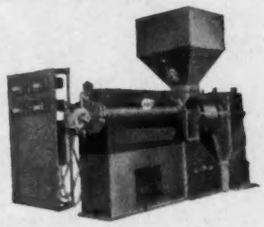
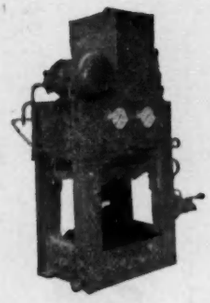
For Plastic moulding complete with pump and Greer-Mercier accumulator.



"DAVIS-STANDARD" EXTRUDING MACHINE FOR THERMOPLASTICS
Designed and built under licence to the highest possible standards and including many interesting features.

"DAVIS-STANDARD" PAY-OFF REEL STAND
Self-contained Pay-Off Reel Stand for reels from 16in. to 36in. flange diameter.



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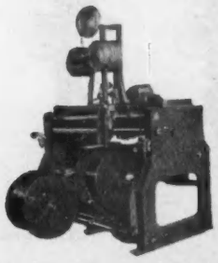
For rope splicing by the clamping method. This unit is unique in construction and affords an example of modern press fabrication with a consequent saving in weight and space.



"DAVIS-STANDARD" AUTOMATIC DUAL TAKE-UP
Continuous and automatic. For reels from 15in. to 30in. flange diameter and up to 17in. overall width.

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Fawcett Preston & Co., Ltd., Bromborough, Cheshire.
and
Finney Presses Limited, Berkley Street, Birmingham 1.
Telephone : MIDland 3795-6-7 Cables : Finhyd, Birmingham 1.

STAND No D239/138

FF/11P3313

WORKS MANAGER required for East Coast Firm of Steel Fabricators in Scotland. Practical knowledge of Production Engineering and Work Study Techniques an advantage. B.Sc.(Eng.) with mature industrial experience preferred. Generous salary, pension scheme, free house.—Apply BOX L 306, Offices of ENGINEERING.

MECHANICAL ENGINEER for design and development work on special-purpose machines and machine tools. Interesting, responsible projects requiring resourceful, ambitious man.—RHODEN PARTNERS, 51, NORTH ROW, W.1. MAYfair 6248. L 249

DEVELOPMENT ENGINEER required by Kent Oil Refinery Limited, Isle of Grain, Rochester, Kent, to carry out engineering studies on Petroleum and Utilities plants, Storage and Pipeline systems. Applicants, aged 28-35, should be in possession of B.Sc. Engineering or Chemical Engineering or equivalent. A minimum of two years' industrial engineering experience in Chemical, Petroleum or allied industry is desirable.—Write stating age, qualifications and experience to BOX EG.990, c/o 191, GRESHAM HOUSE, E.C.2. L 252

DESIGN ENGINEER (27-35), with sound engineering qualifications of not less than H.N.C. or equivalent, required for Vibro Insulator Technical Department in large rubber manufacturing works. Preference will be given to candidates with an engineering or science degree, a good mathematical background and some knowledge of suspension and shock absorption systems, vibration and noise suppression. The successful applicant will be based at Burton-on-Trent but will work in close co-operation with the Sales Department in London on matters of development and design of rubber mountings for industrial, traction and marine installations. Excellent salary and prospects. Pension scheme.—Applications to GROUP PERSONNEL MANAGER, BRITISH TYRE AND RUBBER CO., HERGA HOUSE, VINCENT SQUARE, LONDON, S.W.1. L 305

PRODUCTION ENGINEER as assistant to Works Director required by South Coast Firm of Light Engineers. H.N.C. or equivalent desirable and a thorough working knowledge of welding processes.—Write stating age, experience and salary required to BOX L 299, Offices of ENGINEERING.

APPRENTICE SUPERVISOR required, to organise the setting-up and subsequent running of new Apprentices' Workshop at Fort Dunlopo Candidates should have a background of practical engineering experience, preferably based on an apprenticeship, and technical education to National Certificate level. They should be interested in young people; capable of guiding them in support of studies at Technical College, and of supervising their teaching by craftsmen-instructors. Age 28-42. Experience in a similar capacity desirable, but not essential.—Please write, giving age, education, experience and salary required to PERSONNEL MANAGER (M.12), DUNLOP RUBBER CO., LTD., FORT DUNLOP, ERDINGTON, BIRMINGHAM, 24. L 301

CHIEF ENGINEER required for large Rubber Works, S.E. London. Successful candidate must be to Chartered Mechanical Engineer standard and must also be a leader with proven managerial and organising ability. This is a responsible post with commensurate remuneration, together with Pension Scheme.—Reply in own handwriting enclosing brief details of experience, age, qualifications and salary expected to BOX L 295, Offices of ENGINEERING.

ENGINEERS required by PETER LIND & CO., LTD., ROMNEY HOUSE, TUFTON STREET, WESTMINSTER, S.W.1. Designers and Assistant Site Engineers with 2 to 3 years experience in Reinforced Concrete and general Civil Engineering Works.—Apply in writing only, giving age and full description of experience and stating salary required. L 296

IMPERIAL CHEMICAL INDUSTRIES, LTD., has a vacancy in its London Office for a **TECHNICAL ASSISTANT** for work relating to the design and standardisation of engineering equipment and stores. Candidates should hold the Higher National Certificate and have some experience in workshops and drawing offices.—Applications, giving age and experience, should be made to HEAD OFFICE & REGIONS STAFF DEPARTMENT (GDC), IMPERIAL CHEMICAL HOUSE, MILLBANK, S.W.1. L 298

BRITISH PETROLEUM COMPANY, LIMITED, has a vacancy for an **ELECTRONIC ENGINEER** for work in the Instrument Group at its Research Station at Sunbury-on-Thames. Applications are invited from men with a University Degree in Physics or Electrical Engineering or equivalent. Some experience in the design and development of electronic instruments preferable. Work will include development of instruments for the control and testing of internal combustion engines, for process control, and for chemical and physical measurements. Age under 35. National Service obligations must have been fulfilled. Good Pension Scheme. Salary according to age, qualifications and experience.—Write giving full details, quoting H.3303(a), to BOX 8827, c/o 191, GRESHAM HOUSE, E.C.2. L 292

YOUNG ENGINEER OR CHEMICAL ENGINEER required for project work on Air Drying Plant to meet new applications and conditions. The work involves development of designs and layouts together with the necessary calculations. Previous process plant experience is desirable. This position calls for intelligence and hard work and is an important one in the continued rapid expansion of this Division.—Apply in writing to PERSONNEL MANAGER (DRYER DIVISION), BIRLEC LIMITED, TYBURN ROAD, BIRMINGHAM, 24. L 293

BRITISH HYDROCARBON CHEMICALS, LTD., GRANGEMOUTH, have a vacancy for an **ASSISTANT ELECTRICAL ENGINEER** in the age group 25 to 30 years. Candidates must have a B.Sc. or A.M.I.E.E. and have some experience in the maintenance of switchgear, distribution networks, transformers, electric motors associated with industrial installations operating at 3.3 kV and 440 volts with a demand of some 10,000 kW. The appointment offers first class opportunities in a modern and growing industry. There is a non-contributory Pension Scheme in operation and the Company has its own housing estates. Applicants should give details of background and experience and all applications will be treated in confidence.—Replies to B.H.C., BO'NESS ROAD, GRANGEMOUTH. L 274

MECHANICAL ENGINEER (QUALIFIED) for Contract Administration work in London Office. Experienced in the Design and/or Construction of Steam Power Stations an advantage. Age 25-35. Salary £800-£900 p.a. Free lunches. Pension Fund.—Write stating experience and age to BOX EG.937, c/o 191, GRESHAM HOUSE, E.C.2. L 276

IMPERIAL CHEMICAL INDUSTRIES, LTD., has a vacancy for an **INSPECTING ENGINEER** to carry out inspection of new plant at contractors' works in the north-west of London. Candidates, between the ages of 25 and 35, should possess Higher National Certificate in Mechanical Engineering or a 1st Class M.o.T. Certificate. A knowledge of welding and/or metallurgy would be an advantage.—Applications, giving details of qualifications, experience and salary, should be sent to HEAD OFFICE AND REGIONS STAFF DEPARTMENT (GDC), IMPERIAL CHEMICAL HOUSE, MILLBANK, S.W.1. L 281

THE BRITISH SOCIETY FOR RESEARCH IN AGRICULTURAL ENGINEERING requires a **SCIENTIFIC OFFICER** to work on wheel research and testing of crop driers. 1st or 2nd class hons. degree in engineering or physics essential and interest in applied mechanics and thermodynamics desirable. Salary £539-£933, starting pay according to age and post-graduate experience. F.S.S.U.—Application forms from SECRETARY, N.I.A.E., WREST PARK, SILSOE, BEDS. L 282

CANADA.

A British Company of world wide repute engaged in the manufacture of gear producing machines, equipment and tools, requires, for the Canadian Company,

TECHNICAL SALES REPRESENTATIVES

with knowledge of gear producing machines, tools, etc., and a general knowledge of machine tools; the latter is not essential but preferable. Applicants should give full details of past experience, domestic commitments, etc.

Selected candidates will be required to enter into an agreement for a period of employment and the Company will provide facilities for emigrating, including fares and out-of-pocket expenses.—Write BOX L 323, Offices of ENGINEERING.

ESTIMATOR required by PETER LIND & CO., LTD., ROMNEY HOUSE, TUFTON STREET, WESTMINSTER, S.W.1. Candidates must have good all-round experience in Civil Engineering work, more particularly the design of temporary works such as stagings, cofferdams, etc.—Apply in writing only, giving age and full description of experience and stating salary required. L 278

ESTIMATING AND PROGRESS ENGINEER required by makers of automatic machinery in Enfield. Precision work of great variety.—BOX L 231, Offices of ENGINEERING.

ASSISTANT PLANT ENGINEER required with experience of Contractors' Plant. Must be competent draughtsman capable of preparing plant layouts for contract works. Works Apprenticeship an advantage. Excellent prospects.—Apply with full particulars of age, education, experience to date and salary required to ROBERT M. DOUGLAS (CONTRACTORS), LTD., 395, GEORGE ROAD, ERDINGTON, BIRMINGHAM, 23. L 232

AIRCRAFT COMPANY in Home Counties invites applications for the following posts:—

ASSISTANT MAINTENANCE ENGINEER for department with over 300 employees engaged on various duties relating to factory buildings, heating lighting, plant and machinery.

ASSISTANT LAYOUT ENGINEER for department concerned with all aspects of factory and office layout.

Positions offer particular opportunity in view of possible future projects. Both positions carry senior staff status and appropriate salaries. Qualifications and previous experience in similar work is desirable.

Applications with full details to: WORKS DIRECTOR, BOX L 331, Offices of ENGINEERING.

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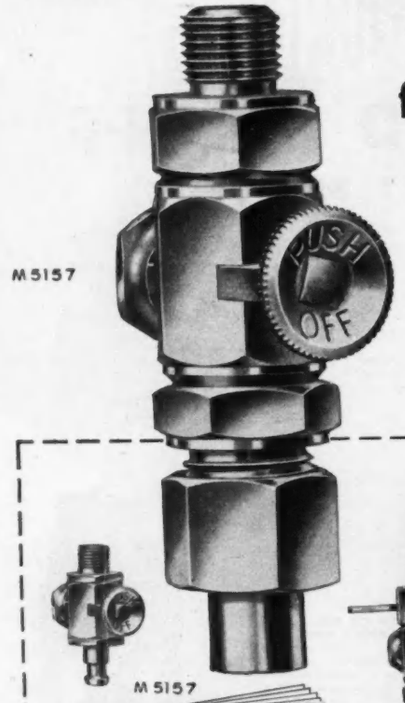
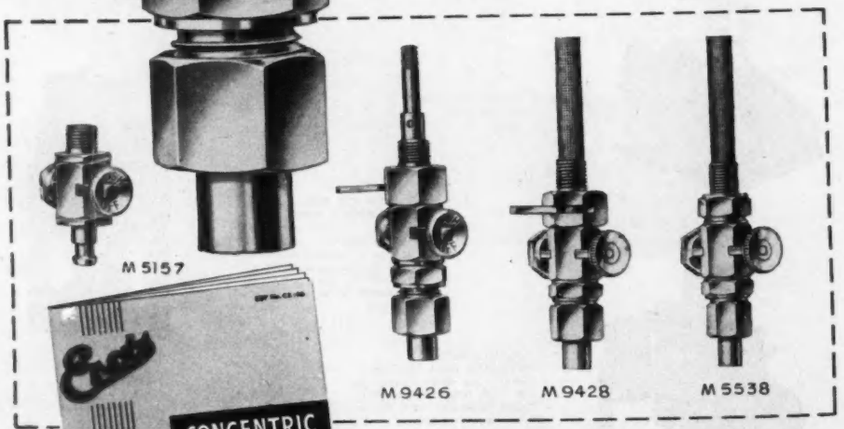
CONCENTRIC CORK-SEATED TAPS

for Motor Cycles and Industrial Engines



M 5157

A high standard of design, manufacture and finish ensures the first-rate efficiency of Enots Concentric Taps. Being cork-seated they are guaranteed 100% leak-proof, prices are moderate and deliveries are good.



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. . . can be found in our Leaflet of Concentric Taps and Filler Caps, No. CT 156 which will be gladly forwarded on request to :-

BENTON & STONE LTD.

ASTON BROOK STREET,
BIRMINGHAM, 6.

See our Exhibit at the International Machine Tool Exhibition 1956 June 22 - July 6, Olympia, London.

JOHN LAING AND SON LIMITED

invite applications for the following technical staff vacancies :—

STRUCTURAL DESIGN ENGINEERS, preferably qualified, with sufficient design experience to undertake work on their own responsibility.

STRUCTURAL DESIGNER/DETAILERS AND DRAUGHTSMEN with good design office experience.

The appointments are mainly at Head Office, and a wide field of interesting work is covered—particularly suitable for those studying for a qualification. The posts are permanent and pensionable. Five-day week. Staff canteen. Sports Club facilities. Please apply in writing stating age, qualifications and experience to :—PERSONNEL MANAGER (S.D.2), JOHN LAING & SON, LIMITED, BUILDING AND CIVIL ENGINEERING CONTRACTORS, PAGE STREET, LONDON, N.W.7. L 73

EXECUTIVE ENGINEER to direct all phases of engineering programme for expanding major American food processing company. Should have college training plus mechanical engineering experience at the executive level. Age 35 to 50.—BOX L 302, Offices of ENGINEERING.

IMPERIAL CHEMICAL INDUSTRIES, LTD., has a vacancy for an **INSPECTING ENGINEER** in the South Wales area. Candidates should be between 34 and 40 and need to be practical Mechanical Engineers who have had a full apprenticeship followed by some years of experience. Either Higher National Certificate or 1st Class M.o.T. Certificate and a knowledge of welding are essential. Residence in or near Monmouth will be necessary.—Applications with brief details of age, qualifications and experience, should be sent to HEAD OFFICE & REGIONS STAFF DEPARTMENT (GDC), IMPERIAL CHEMICAL HOUSE, MILLBANK, S.W.1. L 280

BRITISH PETROLEUM COMPANY LIMITED has vacancies for **MECHANICAL ENGINEERS** in the Middle East. Applicants aged 25-32 must have served a full five-year engineering apprenticeship and possess either National Certificate or Diploma preferably at Higher level, or A.M.I.Mech.E. or 1st Class M.O.T. Certificate plus at least three years on maintenance work either in mills, mines or factories. Attractive salary plus generous allowance in local currency, free passages out and home, free medical attention, good leave arrangements, Pension Scheme, kit allowance, air-conditioned accommodation.—Write giving full details of qualifications and experience, quoting F.506A, to BOX 1773, c/o 191, GRESHAM HOUSE, E.C.2. L 314

SHEEPBRIDGE ENGINEERING LTD., CHESTERFIELD, Offer attractive opportunities for

SENIOR ENGINEERS

capable of upgrading to project work; experienced in Material Handling Plant for Quarries and Collieries. Applications from Designers and Draughtsmen with qualifications in General Engineering will also be given consideration for duties of a suitable nature. Progressive superannuated positions, attractive salaries commensurate with qualifications and experience, with provision of houses for senior positions if required.—Apply, giving details of qualifications, experience, etc., and quoting reference EQD, to the PERSONNEL OFFICER. L 23

CONTRACTS ENGINEERS.

A. REYROLLE & COMPANY LTD., of Hebburn, County Durham, who are the largest firm of switchgear specialists in the world, have vacancies for **CONTRACTS ENGINEERS,** both for Home and Overseas contract work on E.H.V. switchgear. In addition, vacancies also exist for Contracts Engineers to handle work in connection with major industrial installations and medium voltage switchgear. The appointment would be for work at Hebburn and it is customary for the Company to appoint engineers for duties in the overseas and home Area Offices from engineers trained at Hebburn. The work requires initiative and affords the engineer individual responsibility. It is interesting and varied and calls for ability to conduct both technical and commercial negotiations. The desirable qualifications are therefore a Degree or a Higher National Diploma or Higher National Certificate, but candidates having an Ordinary National Certificate who are still proceeding with studies could be considered specially. Applicants need not have specialised previously in switchgear, and if necessary, suitable introductory training would be arranged.—Applications, giving full particulars of technical training and previous experience, should be forwarded to the CONTRACTS MANAGER, A. REYROLLE & CO., LTD., HEBBURN, marked "Personal." L19

Applications invited from **DRAUGHTSMEN OF HIGHER NATIONAL CERTIFICATE** standing for interesting post with important company pleasantly situated within easy reach of Leicester. This post offers good prospects and carries Staff Status and Contributory Pension Scheme. Commencing salary, £650 per annum. Applications, which will be treated in strict confidence, should be addressed in first instance to BOX L 37, Offices of ENGINEERING.

CONCRETE LIMITED, manufacturers of Bison concrete floors and concrete frames, the leaders in this trade, require a **SALES MANAGER** for the Midlands Area, based on Birmingham. He will be a salesman with responsibility for co-ordinating sub-area representatives' work.

The salary is £2000 p.a., and with commission will total about £3000 p.a.; a non-contributory Life Assurance and Pension Scheme substantially increases the value of the emoluments. Applications are invited only from men of good education, social background, good health, initiative and energy, preferably with good professional qualifications and an intimate knowledge of Architectural and Engineering practice in the area, or who have extensive executive-level selling experience.

Applications will be dealt with by a director only and treated in confidence; they should give details of education, training, age, experience, present work and social background. State if interview preferred in London or Birmingham. Mark the envelope "S.M." in top left hand corner and address to CONCRETE LIMITED, 16, NORTHUMBERLAND AVENUE, LONDON, W.C.2. L 100

DEPUTY TO COMPANY CHIEF INSPECTOR required for the Company's Lancashire group of factories which are engaged in the manufacture of high precision mechanical and electro-mechanical mechanisms. Total inspection strength about 600 administered by Chief Inspectors at each separate factory.

He would have overall responsibility for all inspection and would represent the factory group at meetings, conferences, etc., in association with top management. Applicants must have first-class professional inspection abilities and experience, including Government Contract procedure, plus top management outlook and approach.

Applications will be treated in strict confidence and should give full details of education, experience, positions held, together with corresponding salaries. Replies to COMPANY CHIEF INSPECTOR, BOX L 149, Offices of ENGINEERING.

ENGINEERS.

(NEWCASTLE UPON TYNE).

Any skilled man holding an Ord. Nat. Cert. in Mech. Engineering and experienced in Jig and Tool Work is invited to apply for vacancies arising for Trainee Jig and Tool Draughtsmen.

Openings are also available for men to design special purpose Boring and Milling Machines.

Attractive salaries and permanency for good men. Overtime available. Pension Scheme.—Write BOX L 199, Offices of ENGINEERING.

DRAUGHTSMEN.

Vacancies for **SENIOR AND JUNIOR,** preferably with marine background, experience in pipe arrangements for diesel installations an advantage; Good conditions; pension scheme; five day week and excellent prospects open to suitable applicants; Apply giving details and qualifications to the CHIEF DRAUGHTSMAN, NORTH EASTERN MARINE ENGINEERING CO., LTD., WALLSEND-ON-TYNE. L 204

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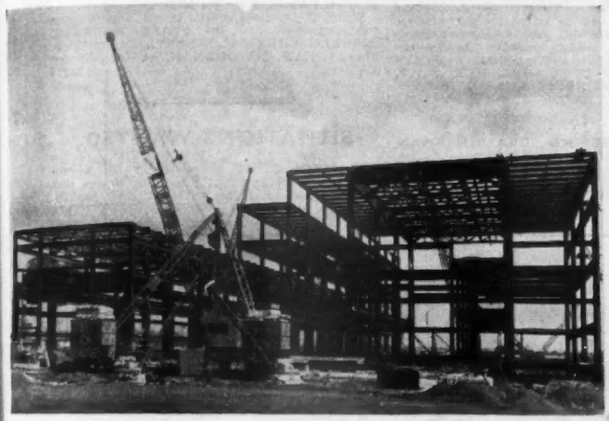
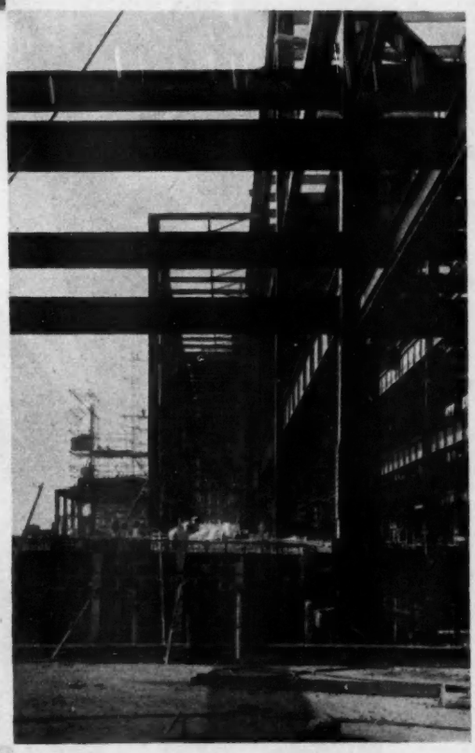


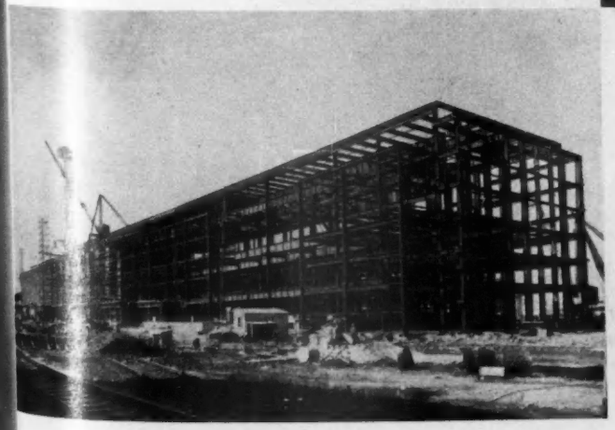
The supply and erection of over 17,000 tons of structural steelwork in the Main Buildings, Switch House and Pump House at the Uskmouth Generating Station, Monmouthshire, was entrusted to Braithwaite & Co. Structural Limited, on the orders of the British Electricity Authority and to the designs of their Chief Engineer, and the Civil Consulting Engineers, L. G. Mouchel & Partners Ltd.



BRAITHWAITE & CO

ENGINEERS LIMITED

BRIDGE & CONSTRUCTIONAL ENGINEERS



London Office

DORLAND HOUSE

REGENT STREET

LONDON SW1

Telephone WHItehall 3993

DEVELOPMENT ENGINEERS AND PHYSICISTS

are required for work in the new and rapidly expanding laboratories of LOUIS NEWMARK, LTD., at New Addington, Surrey. The work includes the design and development of instruments and equipment for the aircraft and allied industries, and some working experience of small electromagnetic instruments is desirable. A degree or similar qualification essential. Good salary based on age and experience. Contributory Pension Scheme.—Apply in writing giving full particulars to: PERSONNEL OFFICER, LOUIS NEWMARK, LTD., PREFECT WORKS, PURLEY WAY, CROYDON. L 326

METALLURGIST, with good qualifications and experience of works practice in the heavy engineering industry, is wanted for a responsible position in a large company with an international reputation. The appointment will necessitate both works control and development work in the field of ferrous metallurgy. Service conditions are likely to appeal to a conscientious man who is prepared to assume responsibility for his judgments and recommendations. The location is in the neighbourhood of Glasgow.—Applications, giving full details of training, experience and salary expectations, will be treated with the utmost confidence and should be addressed to BOX L 332, Offices of ENGINEERING.

MECHANICAL ENGINEER urgently required by Major Oil Company for service in Oil Refinery in Middle East, age not over 35 years. Applicants must be experienced in mechanical engineering design and drawing office procedures applicable to modern refinery practice. University degree or equivalent desirable but not essential if experience sufficiently broad. Two year tour in first instance and salary not less than £2300 p.a. Married accommodation and free family passages available.—Write asking for application form and giving details of education, experience, etc., to BOX EG.129, c/o 191, GRESHAM HOUSE, E.C.2. L 338

WORK STANDARDS

BRIGGS MOTOR BODIES, LTD., require an Engineer to take charge of large Work Standards and Method Improvement department. Applicants must have had experience in Time Study and allied problems with a large engineering concern. Position is a senior one. Salary, pension and other benefits will be commensurate with such position.

Applicant should write with full personal details to MR. J. A. BARKE, GENERAL MANAGER, BRIGGS MOTOR BODIES, LTD., DAGENHAM, ESSEX, under personal and confidential cover, for interview. L 37

Applications are invited for the following positions in the RICHARDSONS WESTGARTH GROUP:—

CHIEF PRODUCTION ENGINEER (functioning in co-operation with Works Manager) for land and marine steam and gas turbines, large marine diesel engines, condensing plants and auxiliaries, at the Group's four Works, all of which are on the North-East Coast. Applicants must have had a wide and thorough experience of production planning and progressing in heavy engineering of the above or similar character, and must be fully conversant with the best modern practice.

CHIEF MECHANICAL ENGINEER for Richardsons Westgarth (Hartlepool) Ltd., to supervise technical departments dealing with design and operation of large and small steam turbines, gas turbines, condensing plants and feed heating systems for land and marine use; blowers, compressors, etc.

YOUNG TECHNICAL ENGINEERS of degree or H.N.C. standard for interesting work in the fields of design of turbines (steam and gas), heat exchangers and condensers, and testing and servicing large power station equipment.

Good terms of remuneration; pension scheme.

Applications should be sent to the Group's Head Office, addressed to:—
THE MANAGING DIRECTOR,
RICHARDSONS, WESTGARTH & CO., LTD.
(P.O. BOX No. 2),
WALLSEND, NORTHUMBERLAND,
and marked "Appointments; Strictly Confidential." They will not be disclosed without consent. L 54

MUNICIPAL MUTUAL INSURANCE LIMITED has vacancies for
ENGINEER SURVEYORS at Birmingham, Glasgow, London, Manchester and Nottingham. Posts are pensionable and permanent to satisfactory candidates who should have served an apprenticeship and have sound practical and theoretical knowledge. Technical qualifications: First Class Ministry of Transport Certificate. Salary: £675 to £1000 per annum.—Apply in own handwriting marking the envelope "Application ENGINEER SURVEYOR" and "PRIVATE AND CONFIDENTIAL" to the CHIEF ENGINEER, 22, OLD QUEEN STREET, WESTMINSTER, S.W.1. L 340

EXPERIENCED ENGINEER wanted as Methods Engineer for medium-sized Brake Lining Manufacturers. Promotion to Assistant Works Manager in approx. two years if suitable. Knowledge of jig and tool design essential. Age preferably 30-40. Commencing Salary £800 to £900 per annum dependent on qualifications. Staff Pension Scheme. Apply giving full details of qualifications and experience, to PERSONNEL OFFICER, BRAKE LININGS LIMITED, BUXTON, DERBYSHIRE. L 205

ASSISTANT CHEMIST (MALE) for Analytical and Development work required by Bryant & May, Ltd., at their London factory. Five-day week; Pension Fund; Co-Partnership and other welfare amenities.—Reply by letter stating age, qualifications and salary required to: PERSONNEL MANAGER (WORKS), BRYANT & MAY, LTD., FAIRFIELD WORKS, BOW, LONDON, E.3, quoting No. 105. L 229

Applications are invited for the post of
ASSISTANT MAINTENANCE ENGINEER
for a large Engineering Company in the West of England.

The successful applicant will be directly responsible to the Chief Works Engineer. He will have responsibilities in the Mechanical and Electrical maintenance of highly specialised machine tools, general plant, and maintenance of plant and equipment. He will be responsible for the control of the large labour force employed on this work. Preference will be given to a Member of the Institute of Mechanical Engineers, but the essential qualifications are a recognised Engineering Apprenticeship and a Higher National Certificate in Engineering.

Housing assistance will be given if required.

Apply giving particulars of qualifications, experience and present salary to "PERSONNEL MANAGER," BOX L 288, Offices of ENGINEERING.

MECHANICAL DRAUGHTSMAN urgently required by Major Oil Company for service in MIDDLE EAST OILFIELDS, age not over 40 years. Should be capable of executing layout drawings for boilers and auxiliaries, diesel pumping installations and of producing detailed drawings and Bills of Materials for works in connection with water storage, pumping and distribution, air conditioning, structural steelwork and simple industrial buildings. Should also be capable of making flow calculation for steam and water. Two year tour and salary not less than £2300 per annum. —Write giving age, brief details of career, etc., and asking for Application Form to BOX EG.130, c/o 191, GRESHAM HOUSE, E.C.2. L 339

SHELL-MEX & B.P. LTD. have vacancies in their London Office and in various parts of the United Kingdom for
QUALIFIED ENGINEERS. Candidates should have a thorough training in Workshops and possess either Corporate Membership of one of the Institutes of Civil or Mechanical Engineers or have passed Parts A and B of one of these Institutions' examinations (or have qualifications entitling them to exemption from such examination). Experience on pumps and pipelines or building construction and civil engineering will be advantageous. Starting salary commensurate with qualifications and experience. Excellent Pension Scheme.—Applications giving personal details and experience to STAFF MANAGER (REF. D/71), SHELL-MEX & B.P. LTD., SHELL-MEX HOUSE, LONDON, W.C.2. L 315

CIVIL ENGINEERING DRAUGHTSMAN required by consulting engineers in Victoria district. Limited experience accepted if good progress made with O.N.C./H.N.C. studies.—Details please to BOX L 285, Offices of ENGINEERING.

IMPERIAL CHEMICAL INDUSTRIES LIMITED' BILLINGHAM DIVISION, requires an experienced **METALLURGIST** for work in the Division Metallurgical Laboratories. The work is varied and deals with the wide range of metallic materials and fabrication processes used in the erection and maintenance of many chemical processes.

The man appointed will be required to assist in the diagnosis of equipment failures and will be expected to undertake original research work; encouragement is given for publication of papers based on such work.

The Division's metallurgists are in regular contact with Research Associations and other industrial laboratories; they also maintain contact with contractors engaged in work for the Division.

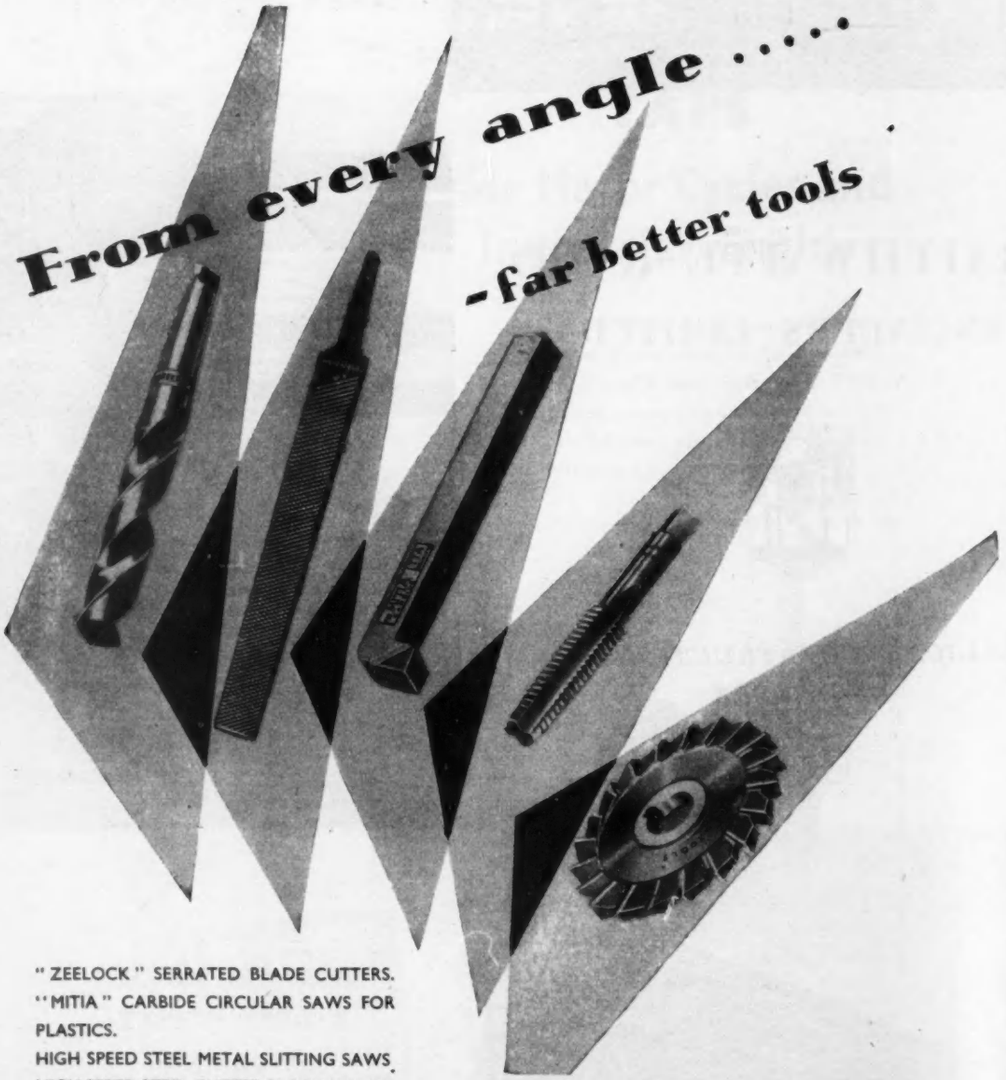
In selected cases, arrangements are made for metallurgists on the Company staff to spend appropriate periods in the Works of a metal-producing or fabricating organisation with a view to acquiring practical experience of such operations.

Candidates should be in the age group of 27-35, should have a good degree in metallurgy and several years' experience in industry, preferably in a branch of the metal or equipment producing industries. The appointment is permanent and pensionable. An attractive salary is offered and assistance can be given towards house purchase.

Write, giving brief details of age, qualifications and experience, to the STAFF MANAGER, IMPERIAL CHEMICAL INDUSTRIES LIMITED, BILLINGHAM, CO. DURHAM, quoting reference G.5. L 316

SITUATIONS WANTED.

A.M.I.MECH.E., 34, interested in the administrative side of Technical Education, desires post in London.—BOX L 228, Offices of ENGINEERING.



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5 in. by 2¼ in. by 10.22 lbs. per ft.
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STEEL PLATE.

10 ft. 0 in. by 5 ft. 0 in. by ½ in. plate.
10 ft. 0 in. by 5 ft. 0 in. by ⅜ in. plate.
10 ft. 0 in. by 5 ft. 0 in. by ¼ in. plate.

Please quote quantities and prices in the first instance to BOX G 1, Offices of ENGINEERING.

THE NEWBURY DIESEL Co. LTD
NEWBURY-ENGLAND
MARINE & INDUSTRIAL
DIESEL ENGINES UP TO 800 H.P.

SURPLUS STAINLESS STEEL. Purchased Sheets, Strips, Bar and Tubes. Please quote sizes, finish and specification.—THE MULBERRY COMPANY, 223, St. John Street, London, E.C.1. Tel.: CLErkenwell 8356-7-8. G 455

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DISCARDED UNGALVANISED STEEL WIRE ROPE. Large quantities 4⅜ in. to 5½ in. circumference in 6/19, 6/24 or 6/37 normal construction and preferably in 100/110 tons tensile, but would consider other tensiles. Please send prices and lengths.—APPLEBY-FRODINGHAM STEEL CO., BRANCH OF THE UNITED STEEL CO's. LTD., SCUNTHORPE, LINCS. Telephone No.: Scunthorpe 3411. L 162

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ALAN MUNTZ & CO., LTD.,
RESEARCH & DEVELOPMENT ENGINEERS,
are pleased to offer experience in
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Also limited high-class Machining and Fitting capacity on the basis of prototype quantities.
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The conception, design and development of **"BLUEBIRD"** was a special project undertaken by

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G 661

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ENGINEERING AGENTS wide experience and excellent connections, are prepared to follow up quotation in the South Wales area.—BOX G 551, Offices of ENGINEERING.

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WORK WANTED FOR ACME GRIDLEY BAR AUTOMATIC, 4-spindle, 2¼-in. diameter capacity, 6½-in. maximum piece length.—K. & L. STEELFOUNDERS & ENGINEERS, LTD., LETCHWORTH, HERTS. 'Phone: Letchworth 1630. L 230

QUALIFIED DESIGN ENGINEERS. Mechanical and Process Engineering. Projects or items of equipment designed or detailed.—Apply BOX L 48, Offices of ENGINEERING.

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WARD, HAGGAS & SMITH FACEPLATE LATHE. Manufactured 1947. Max. swing over bed 5 ft. 11 in., admits 3 ft. 6 in. b.c. Geared chuck 5 ft. dia. Front and rear compound slides, power feeds to both. A.G.H. 18 speeds 4—95 r.p.m. M.D. 20 h.p. 400/3/50.

H. BELL (MACHINE TOOLS) LTD.
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PEARSON
ELECTRO HYDRAULIC GUILLOTINES.

All sizes of machine from ¼ in. to 1 in. mild steel cutting capacity.
Rotary blade-beam action with fast independent return system.
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Edwards

BESCO HAND OPERATED DOUBLE GEARED PLATE BENDING ROLLER. Capacity 48 in. by ½ in. Diameter of rollers 5 in. Weight about 29 cwt.
NEW BESCO PRODUCTION OPEN ENDED UNDERCRANK GEARED GUILLOTINE, Model 48-10. Motorised. Automatic hold-down, adjustable gauges. Capacity 48 in. by ½ in. mild steel. Gap depth 3 in. Weight about 38 cwt.
TWO NEW BESCO GEARED PLATE BENDING ROLLERS, Type F/MB. Capacity 80 in. by 8 s.w.g. mild steel. Diameter of rollers 5½ in.
AS NEW BESCO INCLINABLE PRESS, Type BA18, Mark 11. Motorised 400/3/50. Pressure 10 tons. Stroke adjustable from ⅛ in. to 1¼ in. Centre to back 5½ in.
BURFREE NO. 1A NIBBLING MACHINE. On stand. Motorised 400/3/50. Capacity from ⅛ in. to ⅛ in. mild steel. Gap depth 30 in. Weight about 12 cwt.
ROBERTSON DOUBLE GEARED GANG SLITTING MACHINE. Capacity ½ in. thickness. Between housings 24 in. Weight about 45 cwt.
Photographs of the above are available.
MACHINE TOOLS, NEW AND USED, Of Every Description. Attractive Prices.

F. J. EDWARDS LTD.,
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B.C.S.

ONE—400 K.W. SULZER DIESEL GENERATING SET, 220/440 volts, D.C. complete with Auxiliaries, Spares, etc.
ONE—850 K.W. SULZER DIESEL ALTERNATOR SET, 400/440 volts, 3 phase, 50 cycles, 428 r.p.m., complete with Auxiliaries, etc.
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ONE—80 K.W. GENERAL MOTORS/HOUCHIN DIESEL ALTERNATOR SET, 400/440 volts, 3 phase, 50 cycles, 1500 r.p.m., complete with all Auxiliaries and Switchboard.
ONE—55 K.W. McLAREN/BRUSH DIESEL ALTERNATOR SET, 400/440 volts, 3 phase, 50 cycles, 1000 r.p.m., complete with Auxiliaries and Switchboard.
ONE—40 K.W. SENTINEL/LEROY DIESEL ALTERNATOR SET, 400/230 volts, 3 phase, 50 cycles, 1500 r.p.m., complete with Auxiliaries and Spare Parts. New 1951.
TWO—20 K.W. HILL & CO./DELCO DIESEL GENERATING SETS, 120 volt D.C., 1450 r.p.m., complete with Auxiliaries.
3, CASTLE STREET, CARDIFF.
Tel.: CARDIFF 29246. K 912

Made by James Neill & Co (Sheffield) Ltd., and obtainable from all tool distributors UHJ

Classified Advertisements continued on Page 120

SOAG

SELECTED ITEMS
FROM OUR STOCKS OF LATE TYPE HIGH-CLASS
MACHINE TOOLS

HORIZONTAL BORERS
FEARN-RICHARDS No. 4 "STANDARD TYPE."
SCHARMANN HBSF3, 4 in. diameter spindle.
KEARNS No. 2 "PATENT TYPE," with live spindle.
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KEARNS S Type, with collet type chuck.
WOTAN B85, 3⅛ in. spindle. NEW.
NILES WV9 FLOOR TYPE, 3½ in. dia. spindle.

VERTICAL BORING MILLS
COLBURN 5 ft. DOUBLE COLUMN.
ARMSTRONG CRAVEN 48in. DOUBLE COLUMN.
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GISHOLT 42 in. DOUBLE COLUMN.
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BULLARD 36 in. SINGLE COLUMN.
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CINCINNATI 18 in. (Plain), table 27 in. by 7½ in.
BROWN & SHARPE 2 (light type plain), table 44 in. by 10 in.
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CARTER & WRIGHT No. 0.
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SNOW VB18, Vertical Spindle.
PRATT & WHITNEY 14 in., Vertical Spindle.
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LANDIS Type C, Universal, 10 in. by 24 in.

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CHURCHILL No. 1 Cylinder Grinder.
CHURCHILL HBY.
CHURCHILL HCY.
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RADIAL DRILLS
ARCHDALE 6 ft. Medium Duty.
ASQUITH 3 ft. 6 in., LDR.
ASQUITH 3 ft. 9 in., PORTABLE.
ADCOCK & SHIPLEY, 28 in. PILLAR DRILL.

SLOTTERS
ORMEROD 8 in.
BUTLER 8 in.
BUTLER 12 in., with tilting body.
BUTLER 28 in.
BUTLER 28 in., with electric feed unit.
BUTLER 30 in.

★All machines fully motorised for 400/3/50 supply

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ALSO LATE TYPE PRODUCTION MILLERS, LATHES, GEAR MACHINES, CAPSTANS AND TURRET LATHES, ETC.

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SOAG MACHINE TOOLS LTD.,
JUXON STREET, LONDON, S.E.11
Phone: RELiance 3373
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G 229

B.C.S.

22,000 BABCOCK & WILCOX C.T.M. STEEL CASED WATER TUBE, 260 lb. with Superheater, Economiser by Green, Chaingrate Stoker. All mountings.
15,000 BABCOCK & WILCOX C.T.M. TYPE WATER TUBE, 180 lb. with Superheater, Economiser by Green. All mountings.
TWO—14,000 JOHN THOMPSON 4 DRUM WATER TUBE, 250 lb. with Senior Economiser. All mountings.
30 FT. BY 8 FT. 6 IN. LANCASHIRE BY YATES & THOM, 160 lb. All mountings.
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TWO 16/20 H.P. RUSTON-HORNSBY DIESEL LOCOMOTIVES, 24 in. gauge in first-class condition.
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500 H.P. UNUSED DOUBLE DRUM HAULAGE by Uskside Engineering Company (motor not included); rope speed 8 m.p.h. Each drum will hold 3300 yards of 1 in. rope. Complete, mounted on steel base frame work.
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PENSOTTI 5ft. Motor Driven High Speed VERTICAL BORING MILLS

with taper turning and screw cutting attachment. Max. swing 62 in. dia. Rapid power traverses. 16 speeds from 4 to 145 r.p.m. Motor 28 h.p. Approx. weight 10 tons. 1951-2 machines in excellent condition.

F. J. EDWARDS LTD.,
359, Euston Road, London, N.W.1.
EUSton 4681 G 610

DOUBLE-CHAIN FOUR-SPEED DRAW-BENCH by Sir James Farmer Norton for sale. 10 tons pull, 50 tons breaking strength. Suitable for nickel-chrome tubes up to 1¼ in. diameter by ⅛ in. thick by 20 ft. long when drawn. Gearbox with flexible coupling for high and low speeds. Two sets air-operated plug-polishing gear with air cylinders, etc. Motorised 35 h.p. 750 r.p.m. 400/440/3/50.—Photo and full details from F. J. EDWARDS LTD., 359, EUSTON ROAD, LONDON, N.W.1. L 234

FOR SALE.

OFFERED.

STEEL STORAGE BUILDINGS, HANGARS, GO-DOWNS, TROPICAL SHEDS, FACTORIES, ETC.—Write BELLMAN HANGARS, LTD., HOBART HOUSE, S.W.1. G 648

FOUR "ENGLISH ELECTRIC," PIPE VENTILATED, 220 V. D.C. MOTORS, 250 b.h.p. at 900 r.p.m., with variable speed by shunt control to 500 r.p.m. Frame size C.D. 52/5. Complete with totally-enclosed heavy duty automatic contactor starters with motor-operated field rheostats. All in excellent condition.—Apply to: APPLEBY-FRODINGHAM STEEL CO. (REF. P/B), SCUNTHORPE, LINCS. L 61

ONE MARK VII, SERIES 7, LORRY MOUNTED, DIESEL ELECTRIC, COLES CRANE, in new condition.—BURNASTON ENGINEERING CO., LTD., DERBY AIRPORT, BURNASTON, NR. DERBY. L 34

10 TON CAPACITY OVERHEAD ELECTRIC TRAVELLING CRANE by Herbert Morris, twin girder, cabin controlled, 47 ft. span, 440 volts D.C. supply (2 available).
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18, DUMFRIES PLACE, CARDIFF,
Tel. : 26100. L 49

TWO 9,000 CU. FT. PER HOUR CARBURETTED WATER GAS PLANTS by Humphreys, Glasgow, new 1942, including 10,000 cu. ft. Gas holder, 15,000 gall. storage tank, generators, scrubbers, coolers, exhausters, pumps, purifying tanks, meters, valves, gauges, piping, etc.
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18, DUMFRIES PLACE, CARDIFF.
TEL.: 26100. L 160

1000 KW GENERAL MOTORS/E.M.M. DIESEL ALTERNATOR SET, 400/440 volts, 3 phase, 50 cycles, 0.8 P.F., 4 wire, 750 r.p.m., complete with air starting equipment, auxiliaries, piping, all as worked.—BOX L 152, Offices of ENGINEERING.

ONE—SECONDHAND "NATIONAL" VERTICAL COLD STARTING HEAVY OIL ENGINE, type FA/8—400 Brake Horse Power constant, running at 400 r.p.m., totally enclosed compression ignition type, with solid injection. Fullest details on application. Inspection Company Inspection Reports may be seen.—H. D. DOUGLAS AND CO., 42, BROMLEY ROAD, CATFORD, S.E.6. L 169

TWW

BLISS 306 DOUBLE SIDED GEARED PRESS 8 in. stroke, fast and loose pulley drive.
BLISS 3½B DOUBLE ACTION TOGGLE PRESS, punch stroke 12 in., distance between slides 26 in.; 400/3/50.
BLISS 408A DOUBLE ACTION TOGGLE PRESS, punch stroke 25 in., outer stroke 17 in., bed 72 in. by 50 in.; die cushion; 400-440/3/50.
PLATT TYPE "B" 45 TON CAPACITY D.E. GEARED PRESS, 3 in. stroke; excluding electrics.
HUMPHRIS 200 TON D/S GEARED MULTI-TOGGLE SINGLE ACTION PRESS, 3 in. fixed stroke, table 72 in. by 34 in., 19 in. daylight; die cushion equipment; 400/3/50.

THOS. W. WARD LTD.,

ALBION WORKS - - - - SHEFFIELD
'Phone: 26311 - - - - 'Grams: "Forward"
LONDON: BRETTENHAM HOUSE, STRAND, W.C.2.
'Phone: Temple Bar 1515 (12 lines).
Remember — Ward's might have it!
G 60

FOR SALE.

OWEN GRAPPLE, Type RA610, semi-blade tines, manganese molybdenum alloy cast steel. Rated capacity 7 tons maximum. Tine opening 6ft. 10 in. Distance between tines 4 ft. 10 in. Suitable for open cast or quarry work. By removing two tines, becomes very suitable for placing breakwater stones or similar handling. Can be seen by appointment.—BOX L 254, Offices of ENGINEERING.

FOR SALE, BUELL TURBO TRAY DRYER, steam heated. Height 21 ft. 8½ in. Overall diameter 18 ft. 4 in. New condition. Will accept low price for quick sale. Can be seen working London area.—BOX L 283, Offices of ENGINEERING.

TWO RYDER 5-SLIDE FORGING HAMMERS for sale. Capacity round and square bars up to 1¾ in., tubes up to 3 in. diameter. Weight about 36 cwt. each. Similar 4-slide machine also available. Photos.—F. J. EDWARDS LTD., 41, WATER STREET, BIRMINGHAM, 3. CENtral 7606. L 233

SALES AND VALUATIONS.

AUCTION 10TH MAY, 1956
(unless previously sold).

A PROMINENT FREEHOLD PETROL FILLING STATION, car sales showroom, garage and workshop. Soundly established concern, excellent main road position, thriving Essex town. Valuable freehold property includes attractive private house in immaculate tasteful decorative order. Fully-equipped concern, most valuable extensive inventory. Chartered Accountant's certified sales last full trading year average over £460 weekly. Sound proposition with substantial fixed assets.—Particulars and Conditions of Sale from LINCOLN & CO., INCORPORATED AUCTIONEERS, 9, HANOVER SQUARE, LONDON, W.1. Tel.: GROsvenor 6801 (12 lines). L 313

FOR HIRE.

LATTICE STEEL ERECTION MASTS (light and heavy) 30 ft. to 150 ft. high, for immediate hire.—BELLMAN'S, 21, Hobart House, Grosvenor Place, S.W.1. G 72

MISCELLANEOUS.

FOR THE UNUSUAL IN Technical Glass.—JENCONS (SCIENTIFIC), LTD., MARK ROAD, HEMEL HEMPSTEAD. Boxmoor 4641. L 26

IT'S A GOOD POINT TO REMEMBER

WARDS might have it!

THOS. W. WARD LTD.
ALBION WORKS, SHEFFIELD
G 556

COMPANY MEETING.

THE BRUSH GROUP LIMITED.

WELL-SPREAD ORDER BOOK.

The 67th annual general meeting of The Brush Group Limited, will be held on May 17th, in London.

In his Statement circulated with the Report and Accounts, Sir Ronald W. Matthews, D.L., M.Inst.T. (the Chairman), said that the year ended December 31, 1955, was one in which they held their position in spite of increasing competition from abroad and sharply rising prices at home, coupled with severe dislocation through the dock strike.

Output had been well maintained in the Group, their order book had continued to show an encouraging trend and they had certainly maintained their position in the export market.

At all factories great efforts had been made to speed up deliveries and to improve the reputation for punctuality and for efficient service to the customer. In many markets, and most particularly those of Asia and the Middle East, they were facing fierce and growing competition, particularly on price and delivery, not only from the countries of Western Europe, but from those of Eastern Europe in the sphere of Russian influence. Sir Ronald said: "A concerted effort, for which the utmost support of our suppliers is essential, is needed if the volume of our export trade is to be maintained."

MANUFACTURING

The Chairman then reviewed the Group's widespread manufacturing activities, in the course of which he said:

"Brush Electrical Engineering Company Limited, Loughborough: 1955 has seen the fruition of some of our long-term technical developments and production was started on a new line of turbo-superchargers for Diesel engines. The first production units have been successful and the range is being extended.

During the year Brush Traction Limited, Loughborough, completed its contract for 25 Diesel-electric main line locomotives for Ceylon. Locomotives have also been built for the Steel Company of Wales and the National Coal Board.

The most significant order received during the year is that from the British Transport Commission for 20 main line Diesel-electric locomotives, to a total value of nearly £1¼ million. The locomotives will incorporate Mirrlees twelve-cylinder turbo-charged Diesel engines and Brush generators of the type which are giving satisfactory service in Ceylon.

The British Railways modernisation programme interests us not only directly as builders of Diesel-electric locomotives but also indirectly as the largest manufacturers of Diesel engines in this country. The Maybach high-speed light-weight Diesel engines, for which we have been granted an option to acquire exclusive manufacturing rights in this country, are particularly suitable for use in Diesel-electric and Diesel-hydraulic locomotives and arrangements are in hand for extensive trials of this type of engine by British Railways.

Petters Limited, Staines, completed its 100,000th water-cooled Diesel engine; its later ranges of air-cooled Diesel engines have also been in full production for some time. Towards the end of the year, a new range of marine engines was introduced both for the direct propulsion of small craft and as auxiliaries for larger craft. Air-cooled engines of lighter weight and higher speed are under development.

J. & H. McLaren Limited, Leeds, has undertaken a great deal of preparatory work on two new ranges of engines around which, I feel sure, the future prosperity of our Leeds factory will be built. The PD engine offers one of the most complete air-cooled engine ranges in the world. Tooling is now complete and line production has commenced. Prototype testing has been carried out on the LE engine and it is expected that two engine sizes will be in production during the current financial year.

The National Gas and Oil Engine Company Limited, Ashton-under-Lyne, continued to expand the sale of its range of vertical engines throughout the world. The extended use of natural gas in oil-bearing countries augurs well for the future sale of dual-fuel and gas engines and this Company installed the first engine of this type to run in Pakistan in connection with the newly constructed gas pipe line. The range of horizontal engines has been rationalised and production of these has now been transferred to another Group factory.

Mirrlees, Bickerton & Day, Limited, Stockport: Excellent business, both in the marine and industrial fields, has been achieved with the "K" range of engines, and it is hoped in the near future to extend the power available in this range from 3000 b.h.p., which is the present output of the 12-cylinder supercharged model, to 4000 b.h.p. by the production of a 16-cylinder version."

Sir Ronald continued: "We have a good, well-spread order book, a keen and experienced management and a well-led and co-operative labour force. But we are to a large extent at the mercy of economic forces which are outside our control, and as costs of production rise with the inevitable increase in selling prices, we run grave risks of losing the export markets on which the livelihood of all of us depends.

Only if increased wages are married to increased production, so that the cost of the product remains reasonably stable, can we count on maintaining our proper and necessary share of foreign business."
L 290

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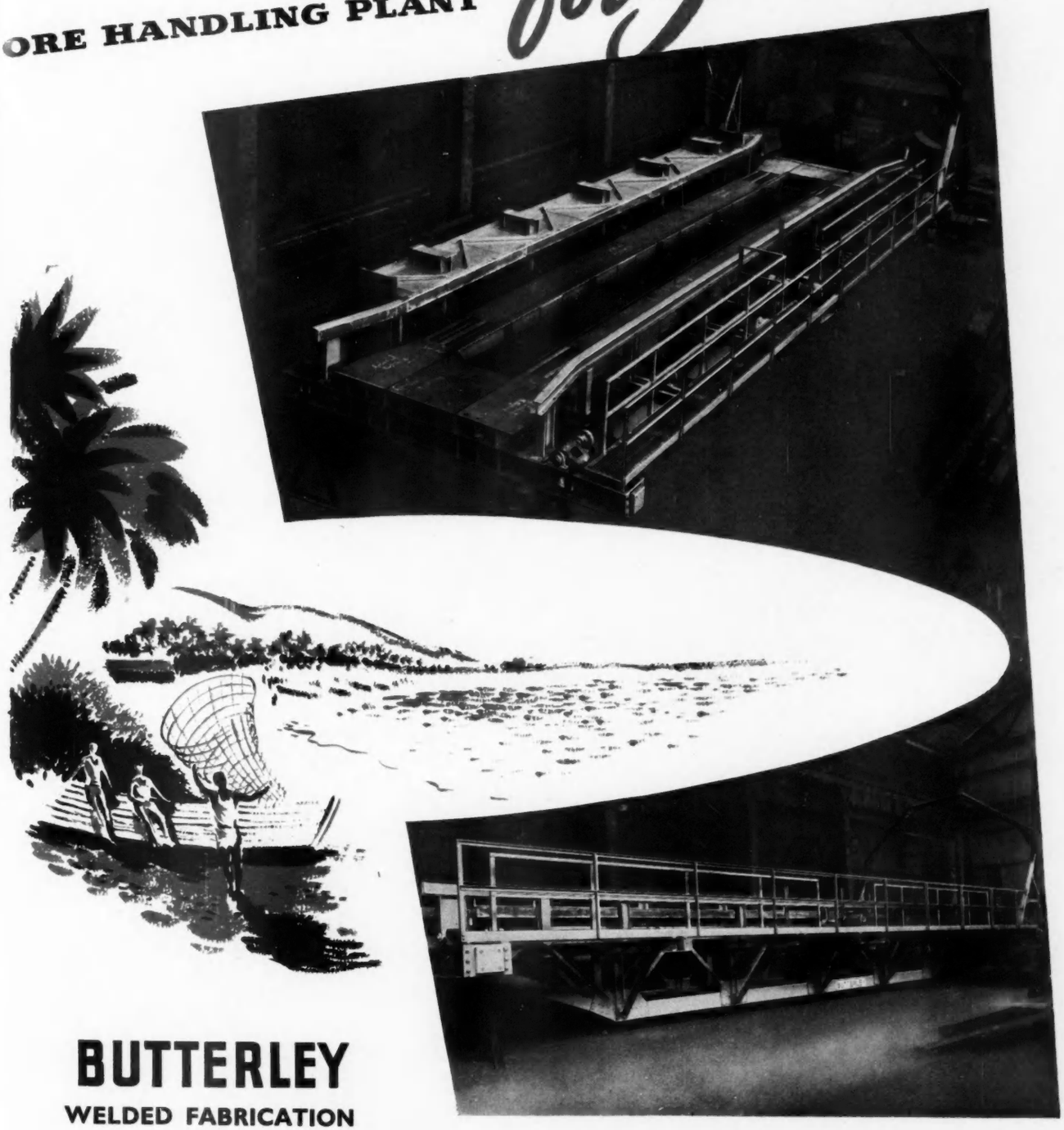
ORE HANDLING PLANT *for Jamaica*



BUTTERLEY

WELDED FABRICATION

Another example of Butterley welded fabrication — this time in Jamaica, British West Indies — is the specially designed travelling bridge for unloading bauxite ore from scrapers and tractor-towing trailers. The span of the platform is 57 ft. 8 in. 38 tons of steelwork were used in the construction of this bridge

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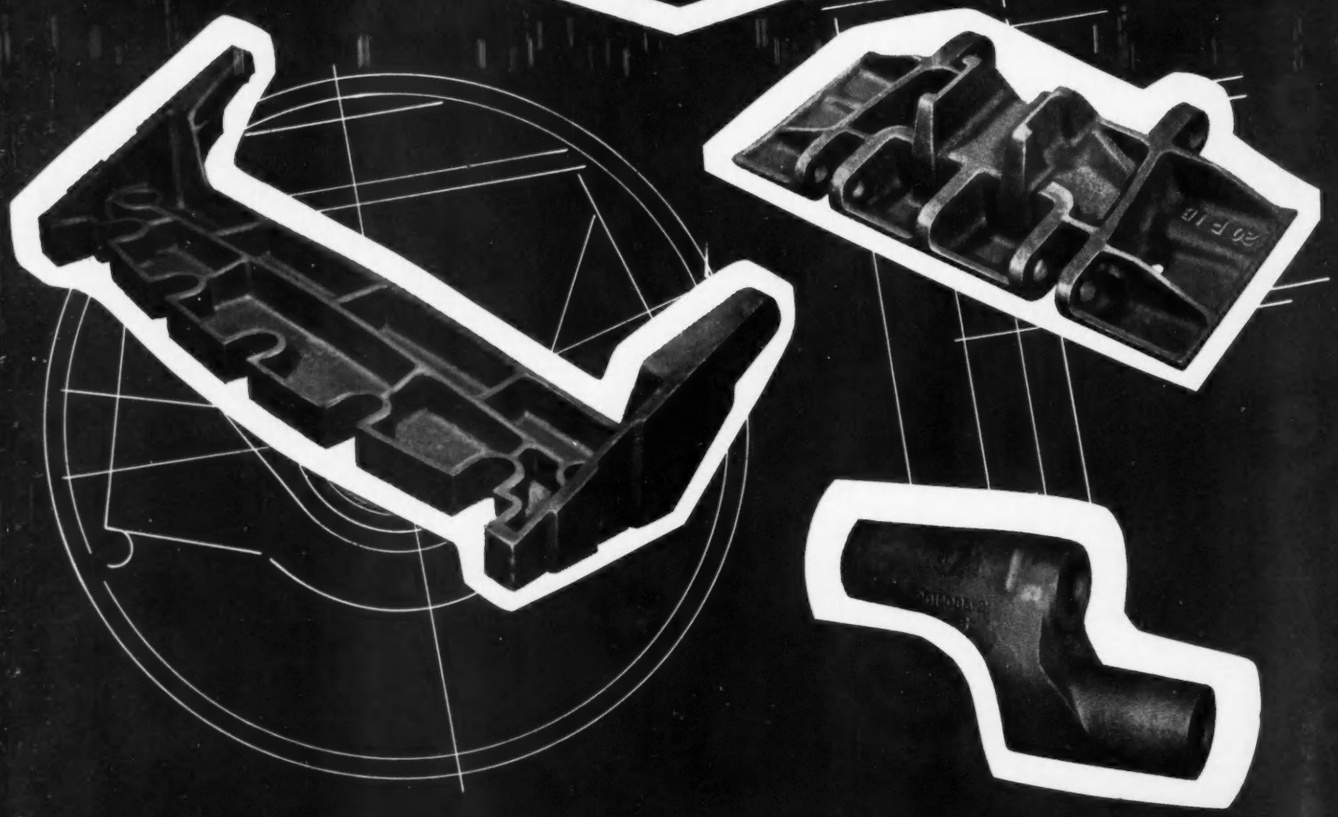
- Tractors and Earthmoving Machinery.



John Fowler & Co. (Leeds) Ltd.
Sprotborough Foundry, Sprotborough, Doncaster.

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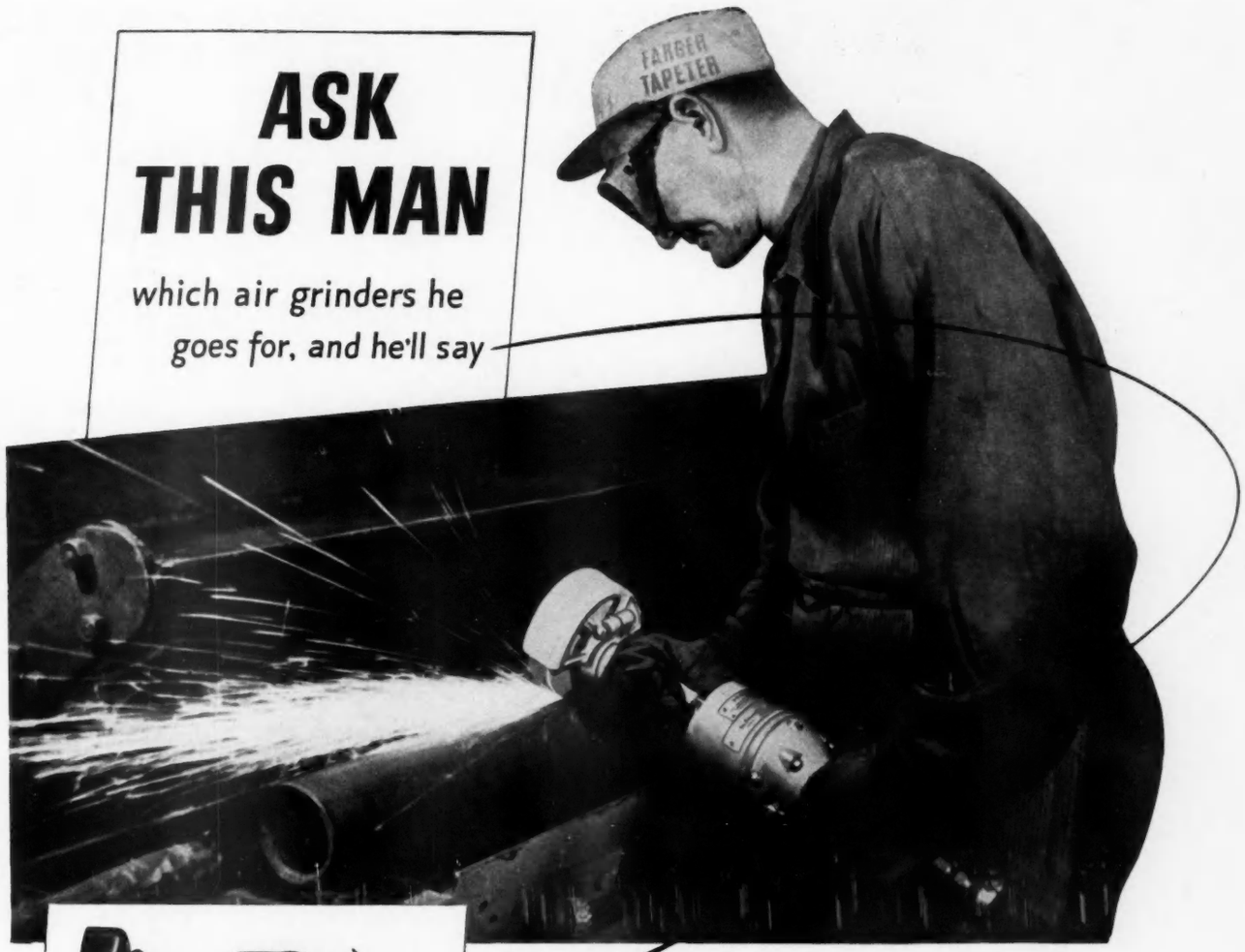
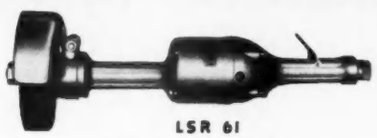
which air grinders he goes for, and he'll say





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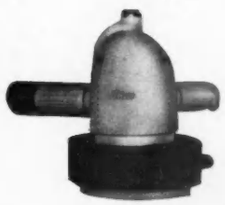

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